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ENVIRONMENTAL FACTORS FOR LAND USE RESTRICTIONS ESTABLISHMENT IN UKRAINE

Purpose. The aim of the article is to determine the weight impact of factors that are directly related to the impact on natural resources and the environment, when restrictions are set on land use. These factors are namely presented in groups of natural, ecological and man-made (technogenic) factors.

Methodology. The factors were identified using the following algorithm: determining a list of factors to consider when establishing land use restrictions; analyzing these factors were and grouping them into thematic categories; developing a questionnaire to assess the significance of each factor; selecting expert groups for the survey; conducting an anonymous survey; verifying the reliability of the factors included in the questionnaire; assessing the weight of each factor was.

Findings. An important basis for ensuring sustainable and efficient land resources and the creation of an effective system of city functioning, among others, is the establishment of land use restrictions. The significance of land use restrictions can be viewed from an environmental, economic, social and legal perspective. Reasonable ecological restrictions help to ensure compliance with established environmental norms and standards, which helps to protect the environment. An important ground for establishing such restrictions is to take into account the interests of all stakeholders in the process and the degree of influence of various factors. In this way, more rational planning and efficient use of territories can be achieved. The factors that are directly related to the state of the environment include groups of natural resources, ecological and man-made factors. The results obtained prove the need to take into account the environmental component when applying an integrated approach to the formation of land use restrictions.

Originality. For the first time, the weight of environmental factors that influence the formation of land use restrictions has been defined.

Practical value. The results obtained as a result of the study should be considered and applied in the preparation and implementation of land use planning to ensure the most efficient use of land resources.

Keywords: *factors, ecology, environment, land use, restrictions, natural resources*

Introduction. Land is a valuable resource, defined as a specific portion of the Earth's surface that serves as the spatial foundation for settlements, various economic activities, and construction. The potential uses of land resources, along with any associated restrictions, significantly influence the economic well-being of entities. This is particularly important in a market economy, where challenges can arise at different stages of development. Consequently, the effective management of land resources is crucial for achieving sustainable economic and social development in most countries. Addressing this issue requires an integrated approach that considers legal, environmental, economic, technical, and social factors.

Ensuring sustainable socio-economic development at the national, regional, and local levels, along with the efficient use of natural resources, particularly land, is a crucial priority today. One of the methods for ensuring the sustainable development of territories is the restrictions of certain types of activities depending on different land categories. In the 1950s and 1960s, development was primarily focused on economic progress and enhancing economic efficiency. However, by the early 1970s, due to the unequal distribution of resources and income and the rising number of impoverished people in developing countries, issues of social justice began to be regarded as equally important as improving economic efficiency.

The prolonged increase in the consumption of natural resources has resulted in environmental degradation and adverse effects on human health. The significance of environmental challenges faced by society continues to grow, driven primarily by urbanization, rising demand for limited natural resources, and the intensifying negative impact of industrial and other forms of pollution on the environment, particularly in urban areas. The real threat was the problem of "limits to growth", which was brought to the attention of the world public by the Club of Rome. To prevent an ecological crisis, it became essential to incorporate environmental protection as a third goal in the development concept. This issue was first addressed at

the UN Conference on the Human Environment in 1972 in Stockholm, where the importance of environmental concerns was officially recognized.

Society's development must occur with nature's preservation in mind. The ecological aspect of sustainable development is deeply intertwined with human activities and overall well-being. Recently, the importance of addressing environmental stability to maintain suitable living conditions has grown significantly. There is a strong ecological interest in safeguarding an environment conducive to human life and social progress. This is reflected in one of the legally established principles of environmental protection, which guarantees a safe ecological environment for people's health and life.

Land use restrictions are a legal instrument that defines clear frameworks and rules for certain types of activities in specific areas. This mechanism is aimed at controlling such aspects of land use as preserving the ecological balance, protecting natural resources, protecting public health, and preventing negative consequences from potentially harmful impacts. In contrast, planning or economic mechanisms are broader and more strategic in nature. Land use restrictions on land use serve as a local regulator, ensuring safety, law and order and protection of territories, while other mechanisms, such as planning, contribute to the realization of strategic goals on the scale of regions and cities, harmonizing its social, economic and environmental development.

The purpose of the article is to determine the weight impact of factors that are directly related to the impact on natural resources and the environment, when restrictions are set. These factors are namely presented in groups of natural, ecological and man-made (technogenic) factors.

Methods. One of the most important mechanisms for ensuring sustainable and efficient land resources using is land use planning. The process that regulates the land use by developing various plans considering environmental, social and economic conditions for society purpose and activity. There is also the land division into different zones with specific regulations and land use restrictions as a part of land use planning [1, 2].

The following scientists are engaged in the search for ways to solve the current tasks and problems related to land use planning and land use restrictions formation: Trong, P., Duc, V., Truong, S., Scholz, W., Almulhim A., Tregub M., Dorosh Y., Lizunova A., Dybnytska M., Dobriak D., Tregub Yu., etc.

Land use restrictions are a set of actions used to establish the optimal mode of land and land plot use. The need to set land use restrictions is due to the need to: preserve natural resources (agricultural, water, forest, mineral); protect historical and cultural heritage; ensure environmental protection (air, water, soil); ensure safety of life of the population; improve conditions of social life of the population [3, 4].

In fact, the land use restrictions are a state interference with property rights. But it is justified in terms of guaranteeing free access to natural resources, social goods and aimed at protecting the common public interests and the third party rights.

In view of the components of property rights, all restrictions on these rights can be viewed in economic, social and environmental aspects. In recent decades, environmental problems and methods of their solution have been gaining more and more attention and importance. The environmental aspect of establishing land use restrictions plays a significant role in the economic and social development of territories, as ecologically clean lands increase the value of land and products grown and aimed at:

Conservation of natural resources and ecosystems. The creation of special zones ensures the preservation of genetic diversity of all types of living organisms.

Prevention of exhaustive use of resources. Land use restrictions of certain land categories help to avoid their irrational or excessive use, which can lead to the depletion of natural resources and deterioration of the environmental situation. Such lands primarily include water, forest, recreational and nature reserve lands.

Ensuring sanitary and hygienic requirements. Land use restrictions around water intake areas, water bodies of ecological value (e.g., forests, nature reserves) contribute to the preservation of ecosystems, which ensures the long-term sustainability of natural resources and stability in agriculture, forestry and tourism.

Reducing the impact of emissions of harmful substances. Establishment of land use restrictions around facilities that are sources of negative environmental impact, compliance with pollution standards in the air, soil, and water is ensured.

A special, most common type of restrictions is the establishment of special regimes on certain territories that limit the possibility of their use. The impact of land use limitations can be assessed from the point of view of the extent of its spread. For example, groups of administrative-territorial units, separate administrative-territorial units, a group of land plots or a separate land plot. Depending on the importance of land use limitations and the extent of its spread, the impact may be local, regional, national and global [5].

The most illustrative examples of the prerequisites for imposing land use restrictions are water, air and soil pollution.

The surface waters in Ukraine cover an area of 24,249 km², which accounts for 4.0 % of the total area. However, according to the State Statistics Service of Ukraine and environmental organizations, only about 20–25 % of these surface waters are considered relatively clean or meet environmental standards.

According to the State Service of Ukraine for Food Safety and Consumer Protection, the primary violations at centralized water supply facilities include the absence of projects for establishing sanitary protection zones for water sources, the lack of projects for sanitary protection strips along water pipes, and the failure to implement measures to enforce restrictions at water intake points and within the first zone of sanitary protection. One of the major violations of water protection legislation is the breach of regulations concerning economic activities within water protection zones and on water fund lands.

The establishment of water protection zones has a significant positive effect on the state of water bodies and, as a result, ecosystems, as they act as a kind of natural filter for pollutants and help reduce their flow into water bodies. Vegetation in these areas helps to retain surface water runoff after precipitation, which reduces the risk of flooding and erosion. By restricting harmful activities, water protection zones help improve the quality of water that can be used for drinking purposes. Cleaner surface water helps reduce the cost of water treatment in water supply systems.

Unreasonable land use restrictions formation can have negative economic, social and environmental consequences, negatively affect infrastructure development and cause a loss of trust in the state and local authorities [6, 7]. From an economic point of view, the land owners may suffer financial losses due to the decrease in the land plots value and failure to receive income because of the limitation of the possibilities of their property use. Businesses may lose opportunities for development, and investors may abandon projects due to a decrease in the investment attractiveness of land plots, which will lead to job losses, reduced investment and tax revenues.

Social consequences are manifested in community dissatisfaction with unjustified restrictions that may be perceived as unfair or discriminatory, which may lead to conflicts between landowners and local authorities. In addition, unjustified restrictions may prevent the development of necessary infrastructure, such as roads, communications, social facilities, which will lead to a deterioration of the quality of life of residents [8].

When restrictions are formed without considering actual environmental risks and conditions, it can result in the inefficient use of natural resources or hinder the adoption of environmentally sustainable practices. This, in turn, can lead to challenges in protecting the environment [9].

In order to correctly implement the land use restrictions and ensure their validity and aimed at socio-economic and ecological balance, it is necessary to carefully study and analyze the factors that influence this process, as well as determine the importance of each of them. The validity of establishing land use restrictions, their legitimacy and expediency can be achieved by taking into account a number of factors that condition this process and determine its consequences.

The factors were identified following this algorithm:

- defining a list of factors to be considered when establishing land use restrictions;
- analyzing the identified factors;
- grouping them into aggregated thematic categories;
- creating a questionnaire to evaluate the importance of the factors;
- identifying expert groups for the survey;
- conducting an anonymous survey;
- verifying the reliability of the factors included in the questionnaire;
- evaluating the weight of the factors.

The research was based on the analysis of legal and regulatory acts [10, 11], scientific literature [12, 13] and the analytical materials [12, 14, 15]. The main focus was done on environmental issues. The results were carried out using methods of collection, systematization, processing, logical analysis and generalization. The method of expert evaluations also was applied during this work [16, 17].

Results. The analysis of the publications of Ukrainian and foreign scientists, the regulatory and legal framework, state information resources, open data, and various types of documentation, such as urban planning and land management was carried out by authors [18, 19]. Research results were presented in the work [20]. The study identified a set of factors that must be taken into account in land use restrictions formation. The authors grouped the entire set of researched factors into eight thematic groups:

- legal;
- administrative;

- informational;
- ecological;
- natural;
- socio-economic;
- functional-spatial;
- technogenic (man-made).

This work examines groups of factors that are directly related to the impact on natural resources and the environment, namely groups of natural, ecological and man-made factors. Among natural factors, the authors highlight those that influence the complexity, development, and efficiency of the territory's functioning. These include geomorphological and geological conditions, the regime and composition of underground and surface waters, the quality and condition of natural resources, as well as the land's bioproductivity [21].

The group of ecological factors encompasses the need to meet environmental safety requirements, including air, water, and soil pollution levels, noise and vibration levels, chemical contamination, and other aspects that variously impact the environment. This group also includes considerations such as limited natural resources, the current ecological condition of environmental components, and ecological risks.

Factors related to human activity (technogenic factors) are identified as a separate group. This group encompasses the environmental impact of production activities, static and dynamic loads, and the environmentalization of material production. Additionally, it includes the effects of war and hostilities in Ukraine, reflected in restricted land use due to soil contamination from military actions, as well as their impact on surface and underground waters, forest resources, and natural reserve fund sites [22, 23].

When developing project documentation, a mandatory component is an assessment of the extent and intensity of the planned activities' environmental impact, identify measures to prevent or mitigate these effects, and evaluate the project's decisions for their alignment with environmental protection needs and safety requirements. This process is known as an environmental impact assessment.

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In further development of the research the authors worked out a questionnaire to reveal the opinion of interested parties regarding the importance of factors in establishing land use restrictions and conducted a survey [24, 25].

Specialists in the field of land management, owners and representatives of authorities were involved as experts. In this way, the opinion of experts with different interests is taken into account:

- those who are professionally related to issues of setting restrictions (Specialists in the field of land management);
- those who take care of their property (owners);
- those whose powers include ensuring the sustainable development of territories representatives of executive and local self-government bodies.

Land managers involving in the questionnaire survey can be explained by the fact that the land use restriction is an object of the State Land Cadastre and is subject to mandatory registration, which is carried out on the basis of the development of land management documentation. Therefore, land managers directly experience all the shortcomings of the process of formation and registration of land use restrictions.

In this study, 100 experts participated in questionnaire survey to determine the weight of factors influencing the land use restrictions process. The number of respondents meets the sample size requirements for analysis. Among them 31 experts are landowners/users, 33 – are representatives of authorities, 36

respondents in the group of professionals on setting restrictions, the vast majority of whom are land managers. In the survey questionnaire, we used a Likert scale from 1 to 5 to construct questions that could measure the level of influence that factors have in the land use restrictions process. Specifically, 1 = strongly disagree; 2 = disagree; 3 = neutral (confused); 4 = agree; and 5 = strongly agree [26, 27].

The reliability of this questionnaire was tested using Cronbach's alpha coefficient and the sum of the correlation coefficient (Corrected Item-Total Correlation). The data were considered reliable if the Cronbach's alpha coefficient was between 0.6 and 0.95, and the total correlation coefficient of the variables was above 0.3 [28]. The value of Cronbach's alpha coefficient and correlation was calculated using the online statistical calculator Data lab. The results of the study show that all independent variables have Cronbach's alpha coefficients of 0.95 and total variable correlation coefficients greater than 0.3. This proves that the data is reliable. The next stage of the study is to assess the importance of various factors depending on the interests of respondents in land use restrictions.

After conducting a survey of experts, factors were evaluated and ranked for the results of the expert survey. The study of weight of the factors was carried out according to the composition of groups of factors. The importance of the factors of each group was analyzed separately for each group of respondents - owners/users, specialists, authorities.

The weight of environmental factors is presented for 3 different groups of experts and shown in Figs. 1–3.

The given data illustrate that the same factors have different weight for different expert groups. This is directly related to their needs and activities. In the group of environmental factors, the most important for landowners/users is the ecological state of environmental components. This is explained by the fact that the condition of soil, air, water affects directly their physical state, and in the case of using land as the main factor of production on the quality of manufactured products. Formation of restrictions can be significantly justified by ensuring ecological safety for health. At the same time, environmental safety standards and environmental risks are the most important for professionals and authorities. This is due to the

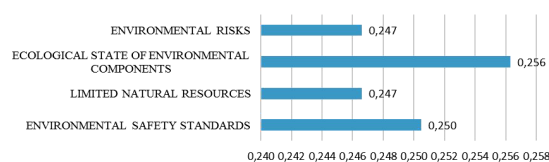


Fig. 1. The weight according to the opinion of land owners/users

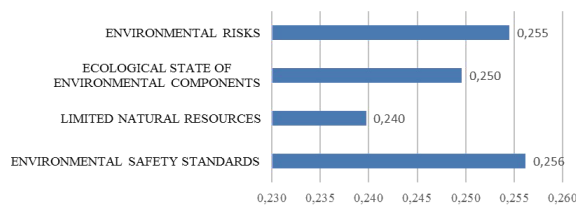


Fig. 2. The weight according to the opinion of professionals

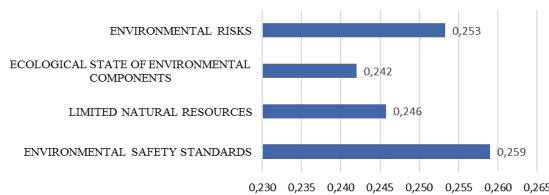


Fig. 3. The weight according to the opinion of representatives of authorities

fact that representatives of these groups must enforce compliance the rules and regulations and are responsible for creating unreasonable risks in their professional field. At the same time, according to experts of these two groups, the least important factor is the limited availability of natural resources. This can be explained by the fact that professionals are not directly connected with the consequences of the limited availability of natural resources, and representatives of government bodies form restrictions established by legislation or justified by special programs.

The weight of natural factors is presented for 3 different groups of experts and shown in Figs. 4–6.

In the group of natural factors, we can observe a pattern that the quality and condition of natural resources and the regime and composition of groundwater and surface water are important factors for all groups. Nature and biodiversity make life possible, provide health and social benefits and drive our economy. Nature is also our best ally in tackling the climate crisis. Instead, according to experts from all groups, geological and geomorphological conditions are the least important despite the fact that these characteristics are sometimes fundamental to land building.

The weight of technogenic factors is presented for 3 different groups of experts and shown in Figs. 7–9.

According to the survey data in the group of technogenic (man-made) factors, military risks are the most important for landowners/users and government officials. This is due to the full-scale invasion of Ukraine by Russia on February 24, 2022. For 2.5 years, the entire territory of Ukraine has been subjected to constant massive rocket and drone attacks. At that time, the most important thing for specialists was the impact of production activities on the environment. Since they are the ones who have to design the territory and production facilities so that the environmental impact is minimal. Instead, according to experts from all groups, statistical and dynamic loads are the least important.

For further assessment in the article the algorithm in order to conduct an integral assessment of the effectiveness of decision-making on the land use restrictions establishment is proposed.

The algorithm consists of three stages:

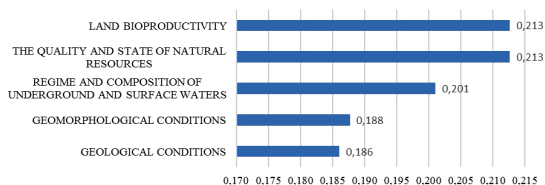


Fig. 4. The weight in the opinion of land owners/users

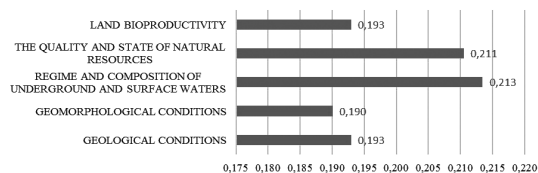


Fig. 5. The weight in the opinion of professionals

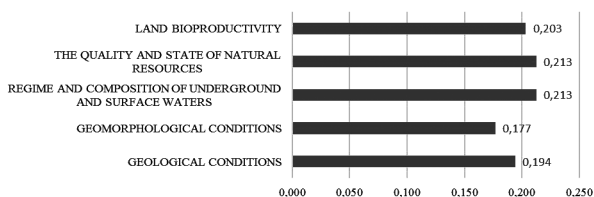


Fig. 6. The weight in the opinion of representatives of authorities

1) assessment of the aggregate impact of the factors within each group;

2) normalization of estimates of the aggregate impact of factors;

3) determination of an integrated assessment.

In the first stage, the overall impact of the factors within each group was evaluated by calculating the ratio of a specific indicator's value to its arithmetic mean, weighted using the following formula

$$O_{ave} = \sum O_k b_k / \sum b_k, \quad (1)$$

where O_{ave} is the average score of the k -factor; O_k – score of the k -factor; b_k – the specific weight of k -factor.

Based on the data of the expert evaluation, by ranking, the specific weight of each factor was calculated according to the formula

$$b_k = R_k / \sum R_k, \quad (2)$$

where R_k is the value of the expert assessment of the priority level of the k -factor.

The sum of the individual weights for the factors within a group must equal 1.00, as each factor's weight represents its contribution to the total (100 percent) priority level of the entire group. Therefore, formula (1) is transformed as follows

$$O_{ave} = \sum O_k b_k. \quad (3)$$

In the second stage, the evaluations of the effects of each factor group underwent additional normalization

$$Q_N = \prod O_k / O_{ave}, \quad (4)$$

where Q_N is normalized score for N groups of factors, including Q_{ecol} ; Q_{nat} ; Q_{tech} ; $\prod O_k$ – the product of the scores of the k^{th} -factor; O_{ave} – the average score of the k^{th} -factor of the corresponding group.

In the third stage, an integral assessment of the effectiveness of decision-making on the land use restrictions establishment was determined. The multi-product model of the Cobb-Douglas function type was used for this purpose. It is a homogeneous linear function of the first degree of aggregate estimates of each group of factors.

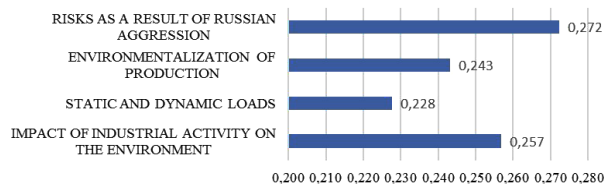


Fig. 7. The weight in the opinion of land owners/users

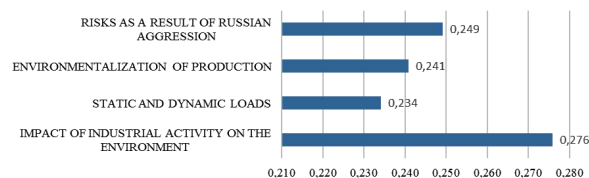


Fig. 8. The weight in the opinion of professionals

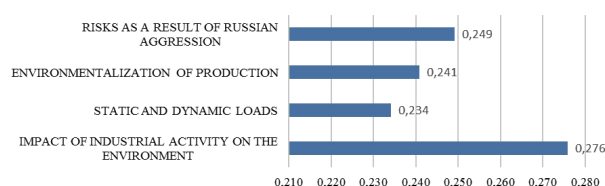


Fig. 9. The weight in the opinion of representatives of authorities

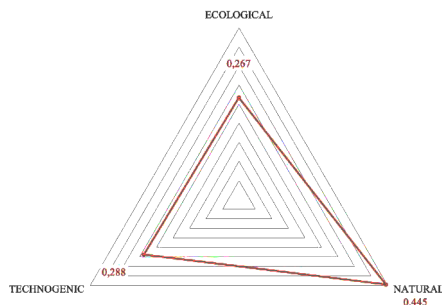


Fig. 10. Weight chart of environmental factors affecting land use restrictions

The Cobb-Douglas function in logarithmic form was used in our case

$$Q = \alpha \ln Q_{ecol} + \beta Q_{nat} + \gamma Q_{tech}, \quad (5)$$

where Q is integral assessment of the effectiveness of decision-making on the land use restrictions establishment; Q_{ecol} – normalized assessment of a group of environmental factors; Q_{nat} – normalized assessment of a group of natural factors; Q_{tech} – normalized assessment of a group of technogenic factors; \ln – natural logarithm; α , β , γ – the share of each group of factors in the formation of an integral assessment of the effectiveness of decision-making; sum of weights should be equal to 1.00.

Using the values of the specific weight of groups of factors, obtained as a result of the questionnaire survey, we had the following results

$$Q = 0.276Q_{ecol} + 0.445Q_{nat} + 0.288Q_{tech}. \quad (6)$$

Fig. 10 shows that the group of factors that had the strongest influence on land use restrictions establishment in Ukraine among environmental factors was the group of natural factors (coefficient 0.445); the second was the group of technogenic factors (coefficient 0.288); the third was the group of ecological factors (coefficient = 0.276).

Discussions. An important basis for ensuring sustainable and efficient land resources and the creation of an effective system of city functioning, among others, is the establishment of land use restrictions. The significance of land use restrictions can be viewed from an environmental, economic, social and legal perspective. Reasonable ecological restrictions help to ensure compliance with established environmental norms and standards, which helps to protect the environment. An important ground for establishing such restrictions is to take into account the interests of all stakeholders in the process and the degree of influence of various factors. In this way, more rational planning and efficient use of territories can be achieved.

The factors that are directly related to the state of the environment include groups of natural resources, ecological and man-made factors. Different stakeholders have different weighting of factors and decision-making should take this into account.

The results obtained in the article prove the need to take into account the environmental component when applying an integrated approach to the formation of land use restrictions. The results obtained during the study should be considered and applied in the preparation and implementation of land use planning to ensure the most efficient use of land resources.

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Екологічні фактори для встановлення обмежень щодо використання земель в Україні

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Мета. Визначення впливу факторів, що безпосередньо пов'язані із впливом на природні ресурси й навколишнє середовище, при встановленні обмежень щодо

землекористування. Ці фактори, зокрема, представлені у групах природних, екологічних і антропогенних (техногенних) факторів.

Методика. Виявлення факторів відбувалося за таким алгоритмом: визначення переліку факторів, що необхідно враховувати при формуванні обмежень землекористування; аналіз виявлених факторів; об'єднання їх в агреговані тематичні групи; розробка анкети для оцінки важливості факторів; визначення експертних груп для проведення опитування; проведення анонімного опитування; перевірка достовірності факторів, включених до анкети; оцінка вагомості факторів.

Результати. Важливою основою для забезпечення сталого та ефективного використання земельних ресурсів і створення ефективної системи функціонування міста, серед іншого, є встановлення обмежень у використанні земель. Значення обмежень землекористування можна розглядати з екологічної, економічної, соціальної та правової точок зору. Обґрунтовані екологічні обмеження допомагають забезпечити дотримання встановлених екологічних норм і стандартів, що сприяє охороні навколишнього природного середовища. Важливою підставою для встановлення таких обмежень є врахування інтересів усіх зацікавлених сторін процесу та ступеня впливу різних факторів. Таким чином можна досягти більш раціонального планування та ефективного використання територій. До факторів, що безпосередньо пов'язані зі станом довкілля, належать групи природних, екологічних і антропогенних факторів. Отримані результати доводять необхідність врахування екологічної складової при застосуванні інтегрованого підходу до формування обмежень у використанні земельних ділянок.

Наукова новизна. Уперше визначена вагомість екологічних факторів, що впливають на формування обмежень у використанні земель.

Практична значимість. Отримані в результаті дослідження результати доцільно враховувати й застосовувати при підготовці та здійсненні землеустрою для забезпечення найбільш ефективного використання земельних ресурсів.

Ключові слова: фактори, екологія, навколишнє середовище, землекористування, обмеження, природні ресурси

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