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PLANNING MODELS OF SANITARY PROTECTION ZONES AROUND MODE-FORMING OBJECTS

Purpose. Given densification of buildings and changes in the urban planning environment, the need arises for more balanced regulation of issues related to the regulation of the impact of mode-forming objects on the surrounding natural environment. In order to comprehensively take into account the spatial component of the localization of pollution sources and the objects that surround them, it is important to conduct modeling and systematization of possible options for the spatial placement of sanitary protection zones around mode-forming objects. This will make it possible to provide well-founded planning decisions and legal support for establishing their boundaries in the area and further legalization.

Methodology. Using the method of system analysis, there was established existence of two fundamentally different groups of planning models of sanitary and protective zones – with and without an overlap. The most frequent cases of localization of sanitary and protective zones in both groups were simulated by the modeling method, based on the nature of the model itself. The use of these methods in general made it possible to classify planning models of sanitary protection zones with further substantiation of their features.

Findings. The obtained results provide a basis for specialists in urban planning, land management and geodesy to use a comprehensive approach in determining the size and configuration of sanitary protection zones around mode-forming objects. It is important that the results can also be used by environmental experts when justifying the sizes of sanitary protection zones.

Originality. For the first time, for sanitary protection zones, grouped planning models have been grouped on which the size and configuration of sanitary protection zones depend that will be established in the area. The models, obtained as a result of the research, were tested for the establishment of sanitary protection zones around the enterprise in Dnipro.

Practical value. The systematized planning models can be used to accurately determine the size of the aggregated sanitary protection zone and its configuration to further establish its boundaries on the ground.

Keywords: *land administration, land development, land industry, territorial planning, buffer zone, zone of land use restriction*

Introduction. The aggravation of environmental problems in urbanized areas is mostly related to the increased negative environmental impact from industrial enterprises and various types of transport.

The planning of the territory of settlements is a complex multi-component process, which is not limited to the development of urban planning documentation, but on the contrary, the development of urban planning documentation is only the first step towards the implementation of a strategic vision of development. At the planning stage, a number of components must be taken into account, which will have further determining importance for the placement of various types of buildings. Taking into account the latest changes in the land legislation of Ukraine, and with the introduction of changes to the regulatory legal acts according to [1], a new type of documentation appeared – a comprehensive spatial development plan, which is both urban planning and land management documentation. Comprehensive plans, among other things, provide for the formation of planning decisions regarding the prospective use of the entire territory of the territorial community.

The initial data for the development of a comprehensive plan are geospatial data on the location and spatial characteristics of objects defined in [2–4], namely:

- objects of the State Land Cadaster – all lands within the state border of Ukraine, the territory of administrative-territorial units, the territory of territorial communities, land use restrictions, land reclamation networks, components of land reclamation networks, land parcels;
- real estate objects, which can be both registered and self-built (except land parcels);
- property rights to real estate, including land parcels, rights restrictions and encumbrances;
- objects of the forest fund, water fund and wetlands;
- territories and objects of the nature reserve fund, objects of the Emerald network and other territories of the eco-network;
- mineral resources, with comprehensive description of its deposits;
- various types of objects of historical and cultural purpose, their territories and buffer zones;
- current demographic situation and prospects;
- objects of production and non-production complex (research and design organizations, educational institutions);
- objects of the social sphere and civil protection;
- objects of engineering infrastructure (water supply, drainage, heat supply, electric energy transmission/distribution and gas distribution systems;
- objects of telephony, pipeline transport, road and transport infrastructure;
- objects of natural and man-made danger located on the territory of the territorial community and adjacent administrative and territorial entities;
- natural and climatic conditions, including the state of the natural environment (lands, soils, water and air space, other environmental components);
- the risk of emergency situations of natural and man-made nature occurring on the territory;
- placement on the territory of the territorial community of objects defined by the General Scheme of Planning of the Territory of Ukraine, the State Strategy of Regional Development of Ukraine, the Strategy of Sustainable Development of Ukraine;
- specific aspects of the concept of integrated development of the territory of the territorial community, approved urban

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planning documentation of the regional and local level, relating to the use of the territory of the territorial community;

- strategic and operational goals determined by the regional development strategy, which extend to the territory of the territorial community, strategic documents on the development of the territorial community;

- forecasts and programs of economic and social development, sectors of the economy, adopted at the level of state, oblast and region, as well as local levels, which extend to the territory of the territorial community;

- strategies, programs and plans in the field of environmental protection and sustainable use of land, soil, water, forests and other natural resources, formation of an eco-network;

- provisions of land management schemes and technical and economic justifications for the use and protection of lands of administrative-territorial units and land management projects on the regulation of the territory of settlements, land management projects on the regulation of territories for urban planning needs, land management plans, land management projects on the organization and establishment of territory boundaries of nature reserve fund as well as other nature conservation purposes, recreational, historical and cultural, forestry purposes, water fund lands and water protection zones, restrictions on the use of lands and their mode-forming objects within the territory of the territorial community, approved before the adoption of a comprehensive plan.

The attributive information of basic geospatial data consists of:

- identifiers of geospatial objects;

- coordinates of geospatial objects;

- geographical names and addresses (if available) of geospatial objects;

- description of topological relations of geospatial objects.

Analyzing the above list of information support and the components of attributive information, which are defined by regulatory documents, the interdisciplinary nature of many issues that are at the intersection of urban planning and land management becomes obvious. Even if we talk about the definition of only one component of the comprehensive spatial development plans of the territories of the territorial community – sanitary and protective zones, then ecologists also appear here and a triad is formed: ecology-land management-urban planning.

Methods. In connection with the interdisciplinary nature of the issue of establishing sanitary protection zones, they are most often a part of fundamental scientific works devoted to the problems of planning organization of cities, rational use of the territories of industrial enterprises, taking into account the ecological aspect. Relevant research in this aspect is based on the works of well-known scientists G. Filvarov, A. Pavlychenko [5, 6], A. Pleshkanovska.

The papers devoted to the problems of land resource management and restrictions in the use of land are written by the following scientists V. Horlachuk, A. Martyn, L. Perovych, O. Petrakovska [2, 3].

Sanitary protection zones are insufficiently researched as an object of the state land cadaster. Therefore, we will analyze foreign scientific publications that directly or indirectly relate to the topic of our research.

In the publication [7], research was conducted on specific examples concerning the sustainable use of land. The authors analyzed the possibilities of the simultaneous existence of agricultural production and other types of industry. It has been established that in the case of the existence of industrial enterprises next to land parcels for the cultivation of agricultural products, additional investment in the implementation of measures for the rational use of land are necessary. The authors have developed investment models that ensure sustainable land use, taking into account greening, especially the need to ensure the control of the purity of air, water, forests and other objects that suffer from the negative impact of industry. Thus, maintaining the balance within the ecosystem is the main direction of ensuring sustainable land use.

In the research [8], the team of authors investigates the applied aspects of the formation of the sphere of environmental activity of an industrial enterprise. All over the world, industrial enterprises in urbanized areas cause a significant hazardous impact on the natural environment, which leads to an aggravation of the ecological situation. The authors believe that one of the strategic directions of the formation of environmental safety is the study of the work of an industrial enterprise, all areas of its activity and prospects for reducing the negative impact of its activity. The work examines specific industrial enterprises that have the greatest impact on the environment, and one of them has a significant negative impact on the entire territory of the sanitary protection zone. Based on the results of the research, a proposal arose to introduce environmental monitoring of industrial enterprises to track their activities and the threat they pose.

In Kazakhstan, the problem of man-made negative impact on the natural environment of industrial enterprises is also acute [9]. The authors point out that in their country there is a significant problem of the disorganization of territories, including the territories of industrial enterprises and sanitary protection zones around them. Therefore, the goal of this study is to develop methods of restructuring industrial areas of urbanized cities. An expert survey was conducted to determine the main factors of the restructuring of industry and industrial territories. Recommendations on the functional planning and ecological organization of territories are provided.

Pavlychenko A. is an author of a significant number of scientific publications on the ecological component of industrial enterprises, especially heavy industry. One of them is [10], it researches the environmental safety of the functioning of mining enterprises. In order to determine value of the man-made negative impact on the environment, the authors used the Leopold matrix, which is formed at different stages of the life cycle of spatial man-made massifs. For the comprehensive implementation of the research, a multifactorial assessment of the effects of rock dumps and sludge storages was carried out, in which Harrington's logistic function was used.

The author [11] analyzed legal acts and a large number of scientific literature works regarding sanitary protection zones and proposed the author's definition of the term "sanitary protection zone". In his scientific work, he notes that the main feature of the sanitary protection zone is the mode-forming object around which it is established, as well as its size, configuration, and restrictions of rights within its boundaries.

The configuration of the boundaries of the restriction zones is one of the most important components during their formation. According to the systematized factors of the formation of sanitary protection zones [3], the planning organization of the land parcel of the mode-forming object is a component of the group of functional planning factors. In turn, industrial enterprises, as mode-forming objects, differ in the type and kind of pollution, which determines their harmfulness class in the future.

The influence of industrial enterprises as potential and actual sources of environmental pollution can be determined not only in the ecological dimension, but also in the social and economic ones. By social, we mean the restriction of the rights of owners/users whose land parcels are located in sanitary protection zones and are subjects of legally defined restrictions on the implementation of certain types of activities, etc. In the economic sense, we understand the change in the value of land parcels, their taxation. This provision applies to all mode-forming objects – in all cases, both social and economic impact will be observed. Only in some cases it will be positive, and in others – negative.

The development of cities was accompanied by spatial sprawl, densification of buildings and often the "absorption" of land parcels of industrial enterprises by agricultural areas.

During the *20th* century, industrial technologies developed very intensively. Today powerful industrial enterprises on their land parcels may have several production facilities with different hazard classes of sanitary and protection zones that intersect and overlap.

Under the conditions of development and increase in the number of private ownership of the main means of production, on the land parcels of industrial enterprises, which are often used inefficiently from the point of view of modern regulations regarding the area of land in various sectoral directions and capacity, additional productions appear, which also require the installation of sanitary and protective zones. All above mentioned peculiarities are to be discussed and systematized.

Results. The above necessitated a detailed analysis of all possible cases of the spatial location of objects that are sources of negative impact on land plots and the spatial organization of sanitary and protective zones around them.

For this purpose, it is necessary to propose some approaches to the systematization of planning models of sanitary protection zones, which should be generalized based on balanced regulatory requirements. Of course, regulatory requirements must be based on a well-founded and rationally selected practical component. Taking into account the above components, grouping can be carried out according to the following principle:

1 group – inside the boundary of land parcel there is complete boundary of sanitary protection zones.

2 group – the boundary of the land parcel is smaller than the boundary of the sanitary protection zones around the mode-forming objects located on it.

During the systematization, as a special case, it is advisable to consider the possibility of crossing several sanitary protection zones of different classes in the middle or outside the land plot on which mode-forming objects and other immovable property used by the enterprise are located.

The groups systematized above can have several types of location – *planning models* – both of mode-forming objects and the boundaries of sanitary protection zones relative to the boundary of the land parcel.

The planning models of the first group are suggested to contain the following cases:

1. The sanitary protection zone around the mode-forming object is located inside the boundary of the land parcel.

2. The boundary of the sanitary protection zone coincides with the boundary of the land parcel.

The first case: there is one separate particular mode-forming object on the land parcel (Fig. 1).

Shown in Fig. 1 planning model is the basic one. In this case, the spatial properties of the mode-forming object are not essential. The class of harmfulness is determined according to the regulations [3], and the sanitary protection zone is designed with a corresponding radius according to state regulations around the mode-forming object. The configuration of the sanitary protection zone should repeat the contour of the mode-forming object in the case of its polygonal or linear configuration, or be in the form of an n-gon in the case of a point object.

The second case: sanitary protection zone is inside the boundary of particular land parcel of property complex where a single mode-forming object is located and also there is a group of other objects which have no sanitary protection zone (Fig.2).

According to Fig. 2, the sanitary protection zone around the mode-forming object extends to the territory within the land parcel of the property complex and coincides with the boundaries of the land parcel: whole or particular segment. The case presented is frequently found according to the information from the scheme of planning restrictions, on which a sanitary protection zone is designed. The analysis should be provided for all possible types of information: from the state land cadaster, which indicates the established boundaries of the land parcel, from register of rights and approved documents on city planning.

In the above systematized cases, which form *the first group of planning models*, there will be no problems with further state registration of restrictions. It is worth noting that, based on the results of the formation of the sanitary protection zone, the establishment of their borders on the ground should not be required, because the use of a certain mode-forming object within the land parcel of the property complex will not lead to an impact on the rights of third parties and will not cause critical deterioration of the environmental condition of the surrounding areas adjacent land parcels. Therefore, it is only expedient to determine the size of the sanitary protection zone and carry out its state registration in case of potentially possible further changes to the boundaries of the land parcels of the property complex.

Planning models that form the *second group* should also be systematized in view of the following cases:

1. All or part of the sanitary protection zone of the mode-forming object is located beyond the boundaries of land parcel.

2. Within the boundaries of the land parcel on which the mode-forming objects are located, their sanitary protection zones intersect, which are completely within the sanitary protection zone of the mode-forming object of the highest class of harmfulness.

3. Inside the land parcel of the property complex with a number of mode-forming objects, sanitary protection zones are designed that intersect and form a common border in the form of polygons of a complex configuration.

All above mentioned planning models should be properly analyzed and described in relation to real situation.

The first case: a sanitary protection zone within and beyond the boundaries of land parcel of a property complex, which has single mode-forming object (Fig. 3).

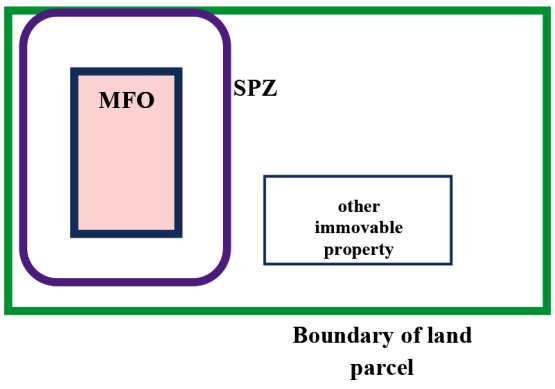


Fig. 1. Planning model of sanitary protection zone (SPZ) around particular mode-forming object (MFO)

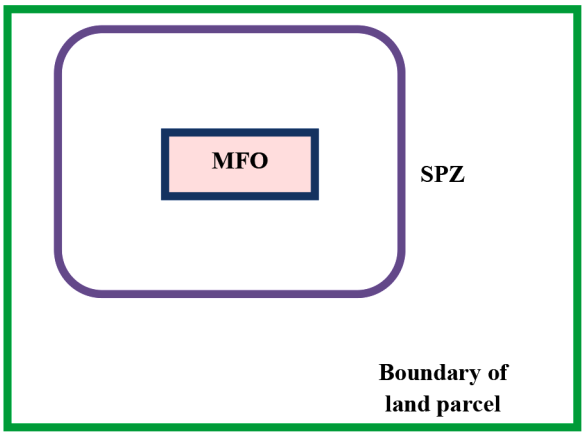
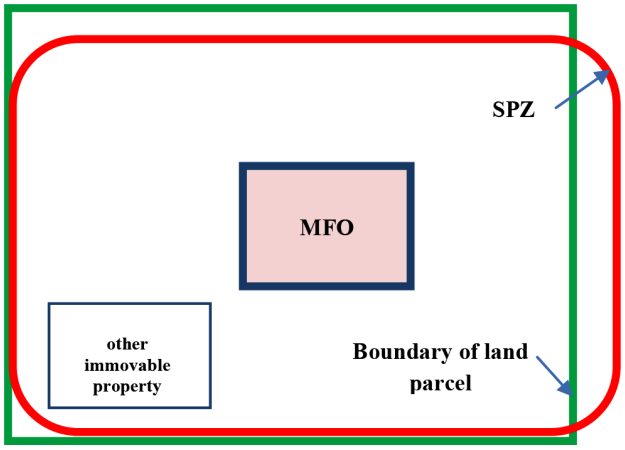


Fig. 2. Planning model of sanitary protection zone around mode-forming object on the land parcel of property complex



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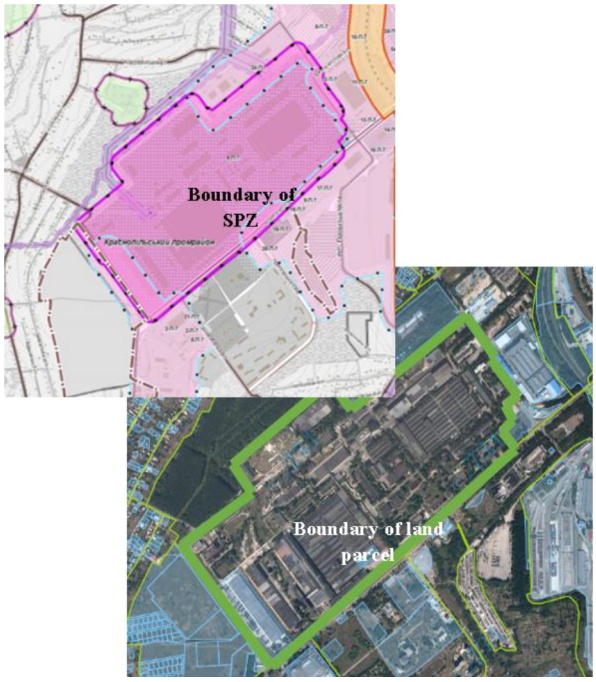

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Fig. 3. The planning model of the sanitary protection zone around the mode-forming object, which extends to the territory within and beyond the land parcel of the property complex:

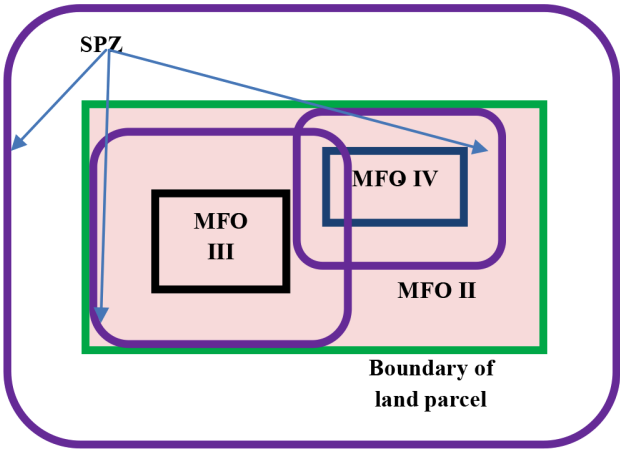
a – according to results of modelling; b – real SPZ on the scheme of planning restrictions

The case in Fig. 3 can occur under different conditions: first, during the initial creation of an industrial enterprise and the formation of a sanitary protection zone; another case has historical features: the radius of the sanitary protection zone could change in connection with changes in the class of harmfulness of the mode-forming object or in connection with an increase in the area it occupies. The real case in Fig. 3, *b* can potentially lead to violation of the rights of adjacent owners or users of land parcels. This possibility can be explained by taking into account the analysis of the historical component of the acquisition of rights to land parcels. The development of property complexes, on which mode-forming objects are located, is long-lasting, as are the legal relations around the land parcels of the respective property complexes. Of course, at a certain historical interval there was a moment when either the mode-forming object did not exist at all, or its capacity changed significantly. This explains the impact of changes in the spatial characteristics of mode-forming sanitary protection zones on adjacent users and owners of land parcels. In case of violation of rights, it is advisable to use the international practice of compensatory payments, but today there is no regulatory and legal support for the corresponding process in Ukraine.

It should be noted that the analysis of the mechanisms of calculation and implementation of compensatory payments is not carried out within the scope of this study, but may be the subject of separate research.

The second case: inside the property complex there are mode-forming objects of different hazard classes, and their sanitary protection zones "overlap" within the sanitary protection zone of a mode-forming object of a higher hazard class (Fig. 4).

In the case of Fig. 4, several mode-forming objects of different hazard classes have sanitary protection zones of different sizes, which intersect, but do not pass beyond the boundaries of the land parcel. Also, there is another mode-forming object of the highest hazard class on the land parcel, and the sanitary protection zone formed around the land parcel includes all others. At the same time, as can be seen in Fig. 4, *b* on the scheme of planning restrictions of the city, there is a similar real situation, when there are private real estate objects – residential buildings – within the sanitary protection zone. State



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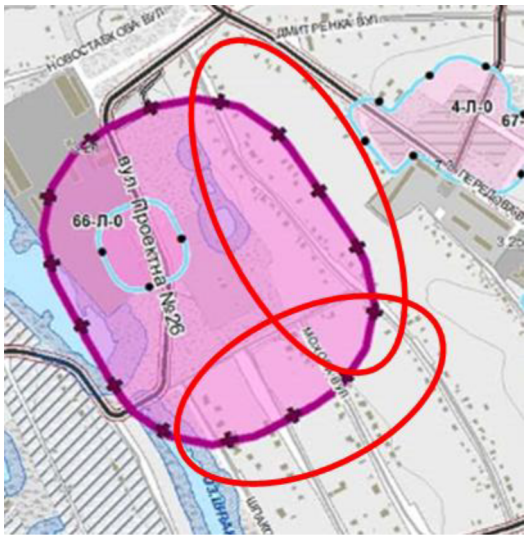

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Fig. 4. The planning model of the sanitary protection zone around several mode-forming objects of different hazard classes within the sanitary protection zone of the highest hazard class:

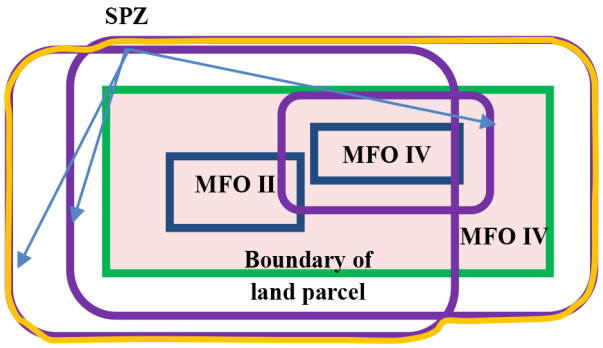
a – according to results of modelling; b – real SPZ on the scheme of planning restrictions

registration should be carried out for each sanitary protection zone separately, but the boundaries of only the largest, that is, aggregated zone, should be set on the territory. Thus, it will be possible to ensure compliance with the rights on land parcels of third parties, similar to the previous situation.

The third case: inside the property complex there are mode-forming objects of different hazard classes and their sanitary protection zones "overlap". At the same time, various sanitary protection zones intersect and their mutual location creates boundaries in the form of complex polygons (Fig. 5).

In the case on Fig. 5, mode-forming objects of different hazard classes within one property complex have sanitary protection zones of different sizes that intersect (overlap). Partially relevant sanitary protection zones may overlap within and beyond the land parcel of the property complex. We believe that it is expedient to carry out the formation of each sanitary protection zone separately, as well as carry out their state registration separately.

As for the set on the territory of the boundaries, it is worth determining the rotation points of the combined (aggregated) sanitary protection zone of various mode-forming objects, which goes beyond the boundaries of the land parcel. Just as it was described above, in Fig. 5, *b* on the scheme of planning restrictions of the city, there is a situation where a few residential buildings are located within the sanitary protection zone. In this case, setting the boundaries of aggregated sanitary protection zone on the territory will allow, as in the previous case, to protect the rights of owners/users of neighbor land parcels.



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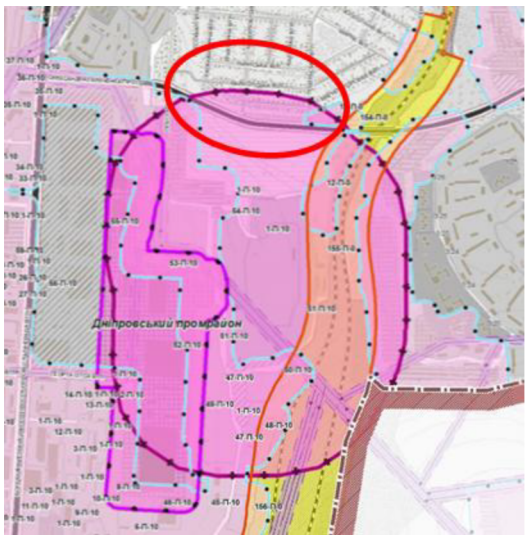

b

Fig. 5. The planning model of the sanitary protection zone in case of their overlapping for mode-forming objects of different hazard classes:

a – according to results of modelling; b – real SPZ on the scheme of planning restrictions

Discussions. Summarizing the study of the above planning models of sanitary protection zones, it should be noted that special attention is necessary when their boundaries are beyond the land parcels' ones of the corresponding mode-forming object or property complexes. In such cases, the question of limiting rights for adjacent lands arises. This makes it necessary in such cases to clearly set the boundaries of the sanitary protection zone on the territory.

In Figs. 3–5, the real situations are shown on the scheme of planning restrictions of the city of Dnipro, when there are individual objects of residential construction, or even entire blocks within the boundaries of the sanitary protection zones. In this case, it is expedient to further develop compensation mechanisms in connection with the location of objects within sanitary protection zones. If the entire land parcel is in the boundaries of the sanitary protection zone, it usually makes no sense to set its boundaries on the territory, in case when they are partially in the boundaries, then the owners/users of the neighbor land parcels should be informed about the location of the sanitary protection zone. In our opinion, when carrying out transactions with land parcels that are partially or completely within the boundaries of the sanitary protection zone, information about the existing restriction should be corrected if such information was not previously entered.

In cases where the sanitary protection zone does not extend to neighbor land outside the land parcels on which mode-forming objects are located, their setting on the territory is not expedient, but when the issue of ensuring the rights of other persons arises, it is important to comply with the requirements of the Constitution of Ukraine, the Civil and Land Codes of Ukraine and by relevant normative legal acts issued in accordance with them.

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Планувальні моделі санітарно-захисних зон навколо режимоутворюючих об'єктів

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Мета. У зв'язку з ущільненням забудови та зміною містобудівного середовища, постає необхідність більш виваженого регулювання питань щодо врегулювання впливу режимоутворюючих об'єктів на навколишнє природне середовище. З метою всебічного врахування просторової складової локалізації джерел забруднення та об'єктів, що їх оточують, важливо провести моделювання й систематизацію можливих варіантів просторового розміщення санітарно-захисних зон навколо режимоутворюючих об'єктів. Це дозволить забезпечити обґрунтовані планувальні рішення та юридичне забезпечення для встановлення їх меж на місцевості й подальшої легалізації.

Методика. Методом системного аналізу було встановлено існування двох принципово різних групи планувальних моделей санітарно-захисних зон – з їх накладанням та без нього. Методом моделювання за характером самої моделі проаналізовані найпоширеніші випадки локалізації санітарно-захисних зон в обох групах. Використання зазначених методів загалом дозволило класифікувати планувальні моделі санітарно-захисних зон із подальшим обґрунтуванням їх особливостей.

Результати. Отримані результати дають підґрунтя фахівцям із містобудування, землеустрою та геодезії до застосування комплексного підходу при визначенні розміру й конфігурації санітарно-захисних зон навколо режимоутворюючих об'єктів. Важливо, що результати також можуть використовуватися фахівцями з екології під час обґрунтування розмірів санітарно-захисних зон.

Наукова новизна. Уперше були згруповані планувальні моделі санітарно-захисних зон, від яких залежить розмір і конфігурація цих зон, що будуть встановлюватися на місцевості. Отримані в результаті дослідження моделі були апробовані для встановлення санітарно-захисних зон навколо підприємства у м. Дніпро.

Практична значимість. Систематизовані планувальні моделі можна використовувати для точного визначення розміру агрегованої санітарно-захисної зони та конфігурації для подальшого встановлення її меж на місцевості.

Ключові слова: *земельне адміністрування, девелопмент земель, земельні відносини, територіальне планування, охоронна зона, зона дії обмежень*

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