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DEVELOPMENT AND USE OF GIS DATABASE FOR TASKS OF NORMATIVE MONETARY EVALUATION OF LAND OF SETTLEMENTS

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Abstract.The paper presents the results of research on the development of a GIS database for the tasks of normative monetary valuation of lands of settlements and highlights the applied aspects of its use on the example of Lychanka village, Dmytriv territorial community, Bucha district, Kyiv region.

An algorithm for developing a GIS database for normative monetary valuation of settlement lands is presented. The presented estimation algorithm allows to carry out

with high accuracy normative monetary estimation of settlements, to carry out its automated updating on a certain date, to receive necessary information on request, to carry out analytical operations and construction of specialized estimation maps.

The development of the GIS database involved the implementation of two stages. At the first stage of formation of the initial land assessment base, the attribute table included data from the Public Cadastral Map of Ukraine on land plots within the settlement by the following items: cadastral number of land plot, area, form of ownership, purpose and functional use of land plot , the number of the cadastral zone in which each land is located, the number of the land assessment area of the settlement, the value of the base value of land, the value of the zonal coefficient (Km2), the coefficient characterizing the functional purpose of the land (Kf), information on the location (street name). The second stage involved the calculation of the value of the normative monetary valuation of each of the 1279 land plots and was performed using the built-in Arc Map function "Calculation of numerical values".

After the development of the GIS database, the testing stage of the developed land assessment database was performed, which involved the use of various query execution, geospatial analysis, the use of buffering functions, topological overlay (intersection).

As a result of the analysis, the following maps were constructed: "Influence of local factors on the distance of land from the center of the settlement", "Influence of local factors on the distance of land from highways", "Influence of local factors on the environmental situation", "Influence of local factors on security electricity", "Influence of local factors on the distance from paved roads", "Influence of local factors on the provision of centralized water supply", "Influence of local factors on the provision of centralized sewerage", "Influence of local factors on the provision of centralized gas supply", "Map plots according to the results of normative monetary assessment" , "Map of the establishment of buffer zones by the value of local coefficients" , "Map of coastal protection strips around water bodies with the allocation of zones of their intersection with land".

Due to the application of special functions of geospatial analysis available in the GIS environment, examples of development of highly informative cartographic materials in the form of special pricing zoning of the territory of the settlement are shown. The expediency of the application of the GIS database for the tasks of monitoring the quality of land, compliance with their legal regime and the possibility of monitoring the implementation of fiscal obligations by landowners and users.
Key words: normative monetary valuation, GIS database, geospatial analysis, buffering, land valuation zoning, maps.

Topicality. It is well known that the land fund of any state is a strategically important component of its successful operation. In Ukraine, 17.06. 2021, the Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine on Land Use Planning" [10] came into force, which provides for a combination of land management and urban planning documentation in the form of a "Comprehensive Spatial Development Plan of the Territorial Community" and expanded the classification of restrictions. land use [4].

This, and the change of paradigm of land management and land use [15] determines the next stage of transformation of the land management system, the issue of land valuation is extremely important. Timely cash receipts in the form of taxes for the use of land in the budgets of the state, territorial communities and owners are evidence of proper fiscal policy and efficient use of land. That is why the timely conduct of regulatory monetary valuation is a significant achievement of the stable economic situation of local communities and the country as a whole.

In this regard, the issue of developing an automated system that would work stably and well-organized in order to calculate the monetary value of land within the settlements and the territory of territorial communities as a whole is quite relevant. The introduction of geographic information systems (GIS) primarily to automate the process of calculating the results of monetary valuation of land in settlements allows you to save manpower and quickly update previously received information.

Analysis of recent research and publications. The urgency of integrating GIS into the land valuation procedure has become even more important in recent years due to the strong development and implementation of IT technologies. Gubar Yu. P. (2019), which highlights the need to use problem-oriented geographic information systems as an indispensable tool for the effective implementation of land relations [5], Palekha Yu.M. , Shipulin VD, Svinaryov AV (2015) substantiate the need for automation of cadastral works, unification of land management documentation in a single database [8].

Similarly, the importance of the use of GIS in real estate valuation is described in the articles by Taratula RB (2017) [12], Tretyaka AM, Panchuk O.Ya., Likhogruda MG (1999) [14], E. Butenko and A. Kononyuk (2019) [3] and many other authors.

In the work of Patichenko OM (2013) proved the feasibility of integrating the State Land and Urban Cadastre on the basis of a specialized geographic information system to ensure the exchange of information between urban GIS and LIS (land information system) normative monetary valuation of land to optimize the interaction of urban planning and land management [9].

Given the above, the tasks of digitalization of land valuation works are quite relevant, which is consistent with the modern concept of automation in land, urban cadastre and land management.

The purpose of the work is to improve the algorithm for developing a GIS database for normative monetary valuation of the settlement and the use of its results.

Materials and methods of research. The object of the study was the village of Lychanka, Dmytriv Territorial Community, Bucha District, Kyiv Region.

The research used materials of the normative monetary valuation of land plots (NVLP) as of 2007, including graphic materials of NVLP (in particular, soil boundaries) [13], information on cadastral division and land plots of Lychanka village - public cadastral map of Ukraine - more PCMU) [11].

The calculation of the monetary valuation of land was carried out in accordance with existing regulations and guidance materials [5, 7, 10].

An integral part of the normative monetary valuation of the settlement with the use of GIS is the creation of new and the use of existing cartographic materials. Binding, digitization of cartographic bases, formation of GIS database and geospatial analysis were performed using ArcGis 10.2 software.

The PCMU-based raster map base was linked to the WGS_1984_UTM_Zone_36N coordinate system and transformed from .jpeg to .tif. Data entry from the PCMU was carried out using a keyboard.

Research results and their discussion. Based on the original raster image of the village of Lychanka in the context of cadastral division by digitization, the main vector layer was created, with the identification of 1279 land plots within it (Fig. 1).

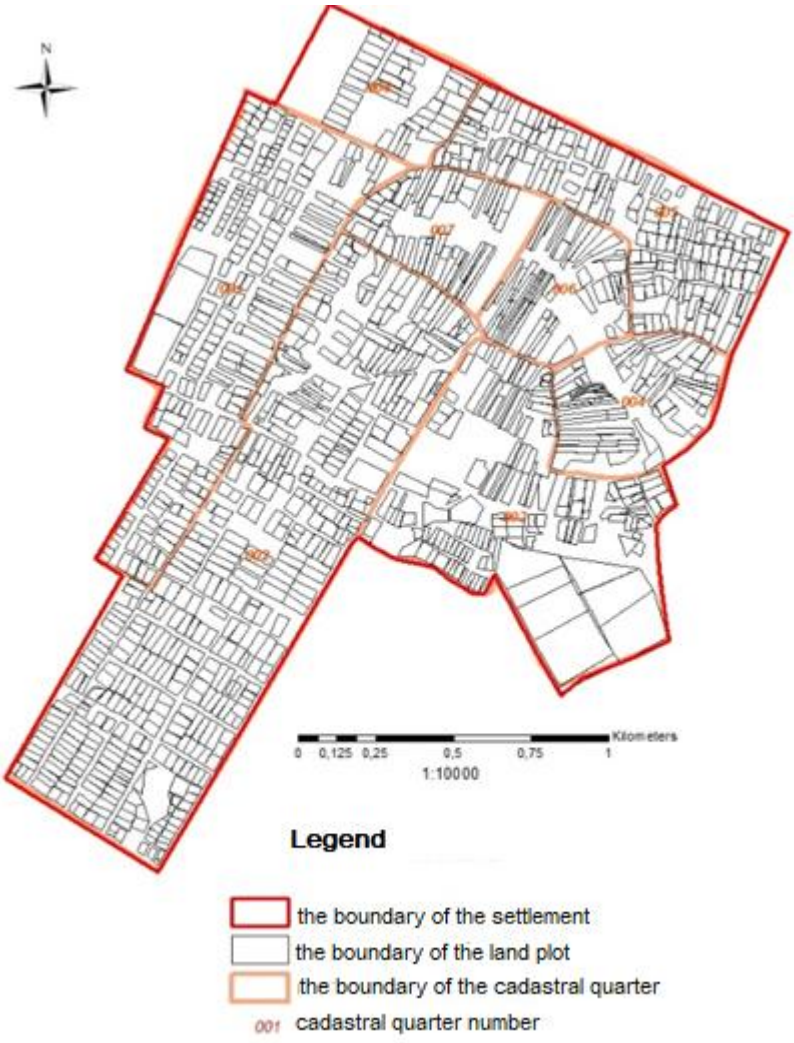


Fig. 1. Vector layer of cadastral division of the settlement

Together, as a result of digitization of the source materials, 4 vector layers were obtained: cadastral division of the settlement (a), land valuation structuring (b), functional use (c), soil cover within the village of Lychanka (d) (Fig. 2).

In addition to vector graphic materials with spatial and coordinate data, an important component in creating a cadastre is semantic data. Descriptive data play an important supporting role and serve as an information basis for the identification of graphical objects, queries, calculations, analytical operations, mathematical modeling.

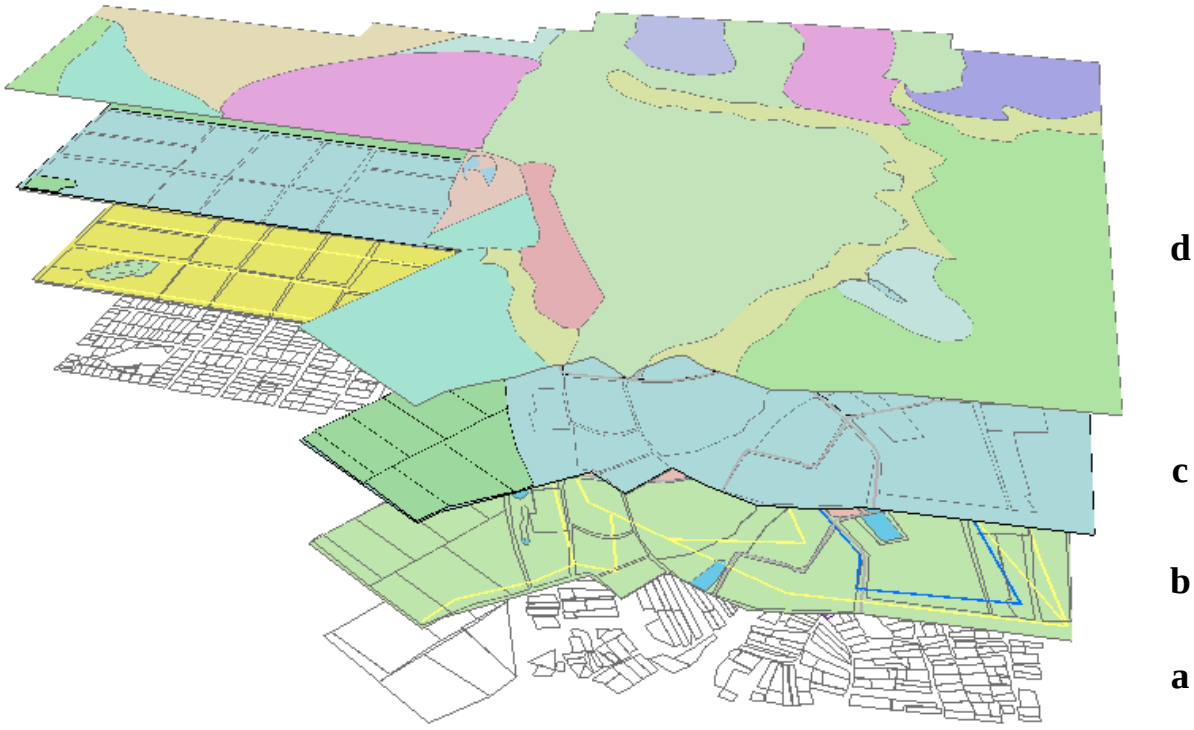


Fig. 2. Architecture of vector GIS layers on the territory of the village of Lichanka

At the first stage of formation of the land assessment base, data from the State Land Cadastre on land plots within the settlement were entered into the attribute table, namely:

- cadastral number of the land plot;
- area, ha;
- ownership;
- purpose and functional use of the land plot.

For land plots within the settlement, in addition to the purpose of the land plot, the following data was added to the database:

- number of the cadastral zone in which each land plot is located;
- number of the land assessment area of the settlement;
- the base value of land;
- the value of the zonal coefficient (Km2)
- coefficient that characterizes the functional purpose of the land plot (Kf);
- information on the location (street name).

A fragment of the database is shown in Figure 3.

OBJE	cad_number	ownership	S_ha	purpose
1	3222484601:01:002:5179	Private property	0,018	03.07 For the construction and maintenance of trade buildings for the construction and m
2	3222484601:01:002:5083	Private property	0,08	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
3	3222484601:01:002:5028	Private property	0,1459	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
4	3222484601:01:002:5017	Private property	0,1459	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
5	3222484601:01:002:0292	Private property	0,11	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
6	3222484601:01:002:5056	Private property	0,1	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
7	3222484601:01:002:5087	Private property	0,1072	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
8	3222484601:01:002:5029	Private property	0,08	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
9	3222484601:01:002:5055	Private property	0,1	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
10	3222484601:01:002:5012	Private property	0,1	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
11	3222484601:01:002:0260	Private property	0,149	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
12	3222484601:01:002:0281	Private property	0,149	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
13	3222484601:01:002:5041	Private property	0,149	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
14	3222484601:01:002:0189	Private property	0,149	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
15	3222484601:01:002:0187	Private property	0,149	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
16	3222484601:01:002:5030	Private property	0,08	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
17	3222484601:01:002:5218	Private property	0,06	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
18	3222484601:01:002:5162	Private property	0,075	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
19	3222484601:01:002:5169	Private property	0,1013	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
20	3222484601:01:002:5064	Private property	0,1013	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
21	3222484601:01:002:5199	Private property	0,0107	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
22	3222484601:01:002:5010	Private property	0,1937	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
23	3222484601:01:002:5101	Private property	0,097	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
24	3222484601:01:002:0110	Private property	0,097	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
25	3222484601:01:002:0111	Private property	0,097	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
26	3222484601:01:002:0136	Private property	0,097	02.01 For the construction and maintenance of a dwelling house, outbuildings and struct
27	3222484601:01:002:0101	Private property	0,097	02.01 Для будівництва і обслуговування житлового будинку, господарських будіве

Fig. 3. A fragment of the attribute table of the database

The values of the normative monetary valuation of each land plot were calculated using the built-in calculation function.

As a result of these actions and the development of land valuation database, it became possible to conduct automated identification of any land and obtain available information, which as an example, structured by 12 indicators (Fig. 4). However, due to the expansion of the list of restrictions on land use that can be established by a comprehensive plan of spatial development of the territorial community, the general plan of the settlement, a detailed plan of the territory [4], these indicators need expanded.

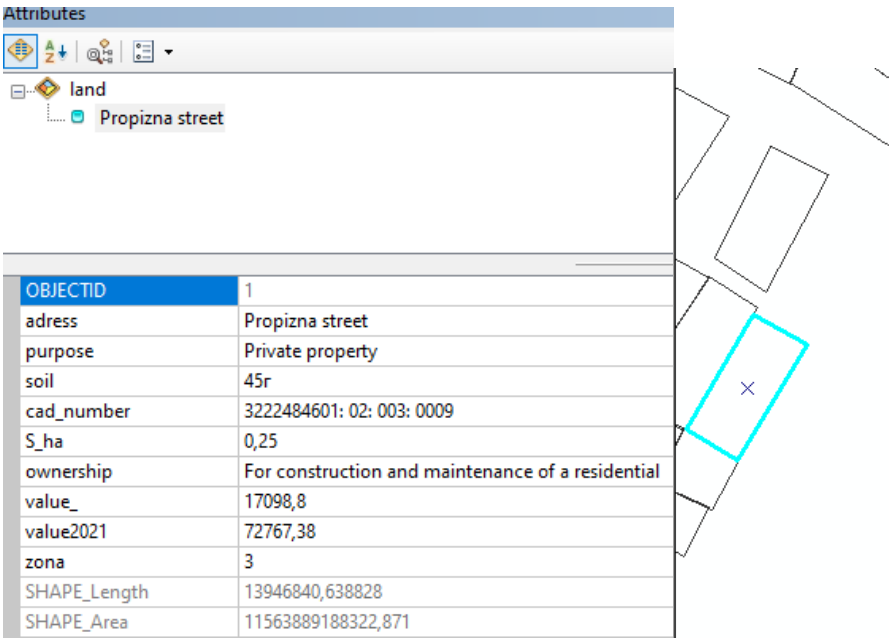


Fig. 4. Results of the information request on the land plot for construction and maintenance of a residential building, outbuildings and structures with cadastral number 3222484601: 02: 003: 0009

An important advantage of GIS is the ability to create complex queries, especially in a large amount of disparate data. In order to demonstrate the functionality of the developed base, a search was performed for the attributes of the availability of centralized sewerage and water supply on land plots (Fig. 5).

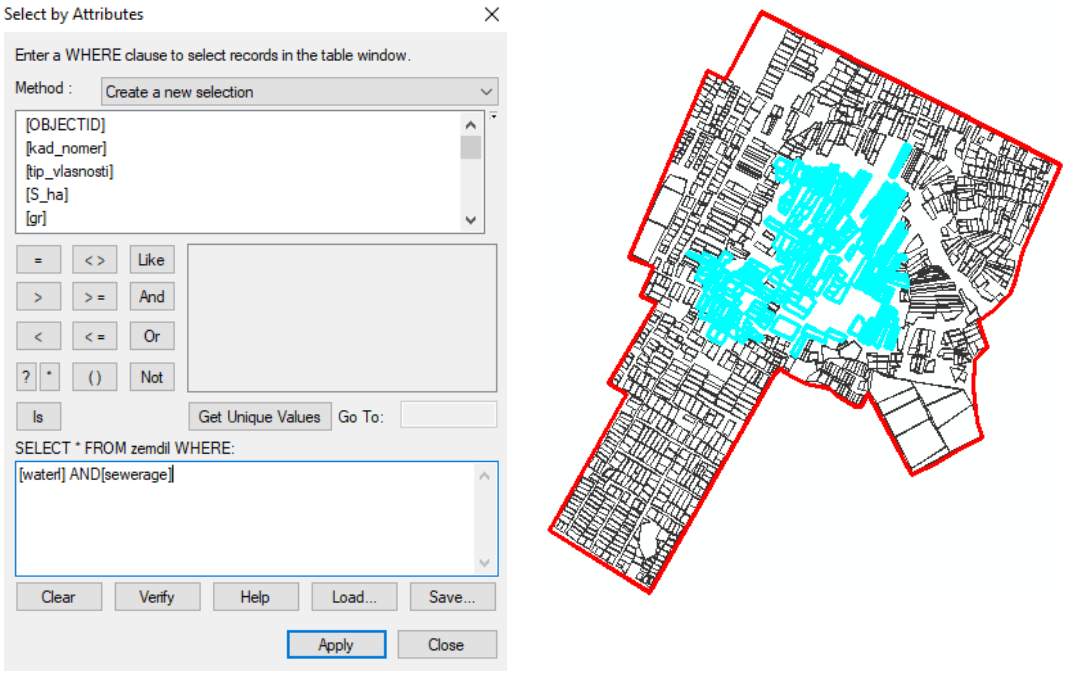


Fig. 5. The result of the query for the attributes of local factors (centralized

sewerage and water supply)

Appropriate maps were created to visually display the influence of local factors in the automated mode (Fig. 6-13).

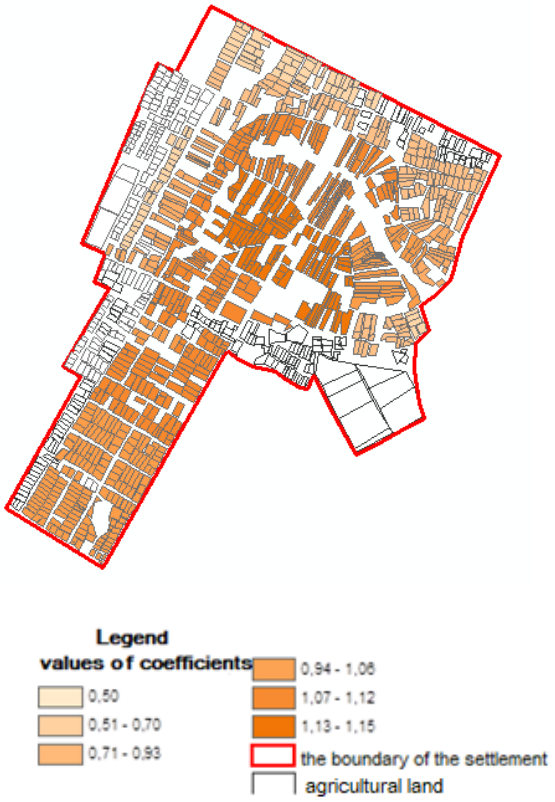


Fig. 6. Influence of local factors concerning the distance of the land plot from the center of the settlement

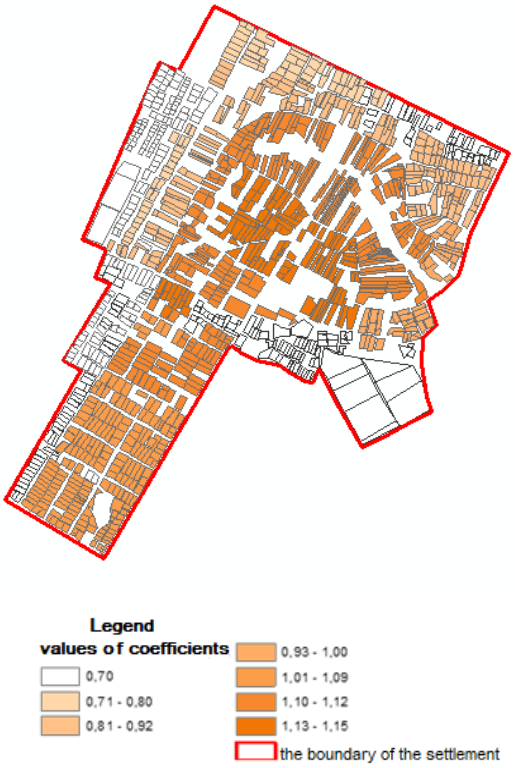
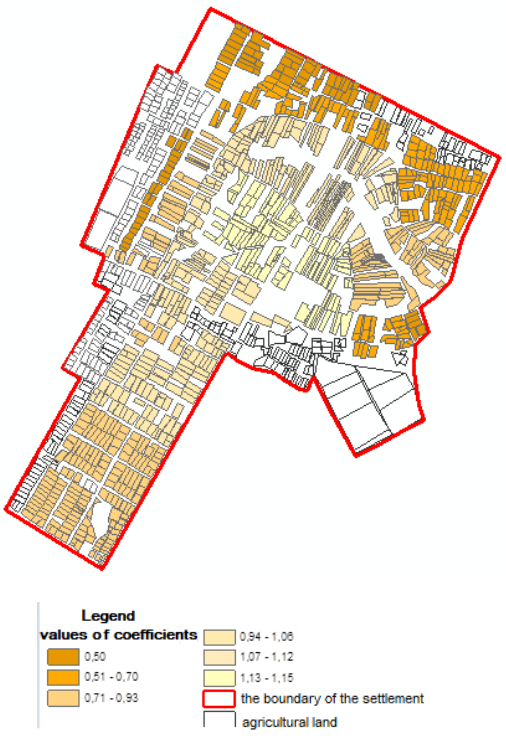


Fig. 7. Influence of local factors concerning the distance of the land plot from the highways



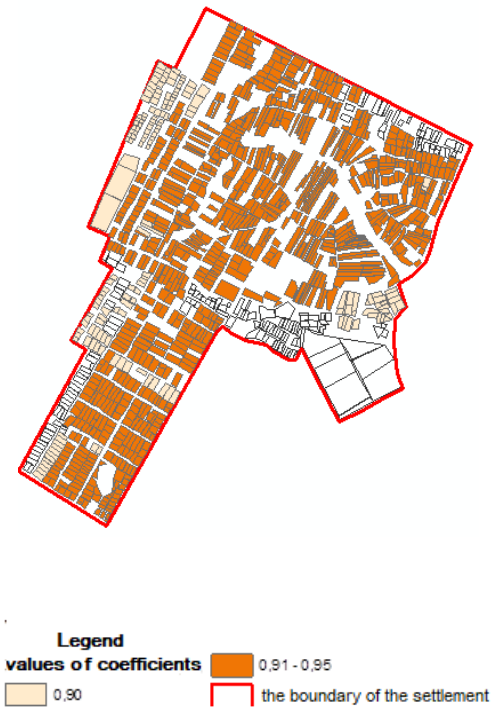


Fig. 8. Influence of local factorsconcerning the ecological situation

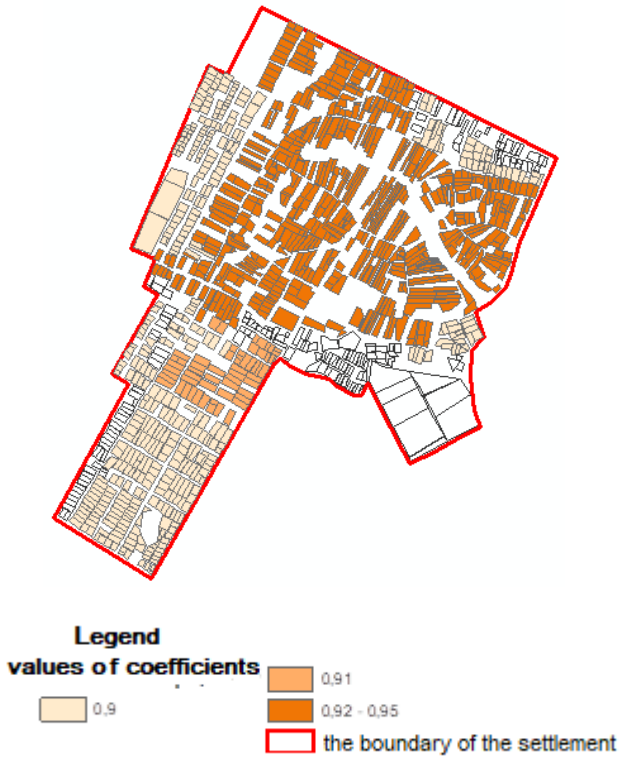


Fig. 9. Influence of local factors concerning electricity supply

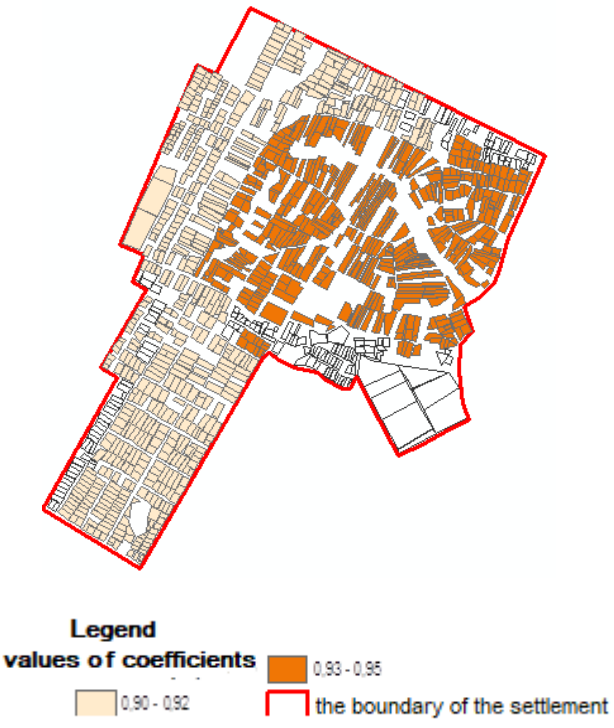


Fig. 10. Influence of local factorsconcerning the distance from the paved road

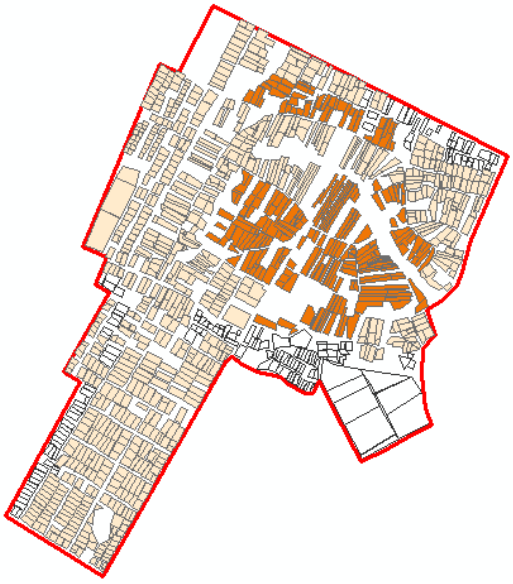


Fig. 11. Influence of local factors concerningproviding centralized water supply

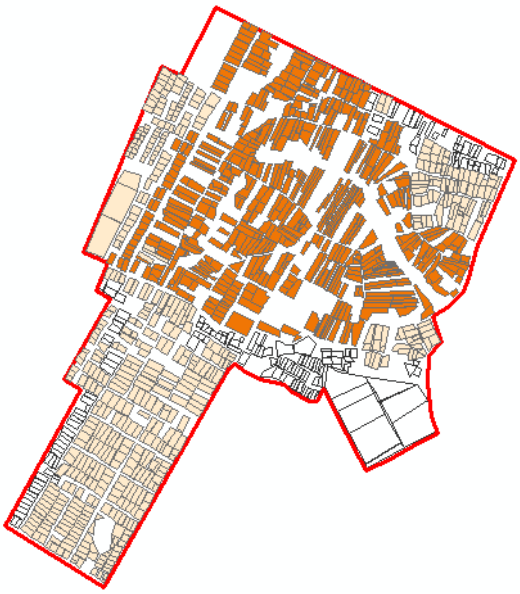


Fig. 12. Influence of local factorsconcerning the provision of centralized sewerage

Fig. 13. Influence of local factorsconcerning providing centralized gas supply

The obtained maps sufficiently demonstrate all the technical components of the formation of the value of the normative monetary valuation of lands of the settlement and serve as a highly informative source for the governing bodies of the local community, potential investors, fiscal units and interested legal entities.

During the work, buffer zones were also established to determine the influence of local factors, such as: distance from the center, distance to roads of urban significance, distance to paved roads. An example of the use of buffer zones in this aspect is shown in Fig. 14.

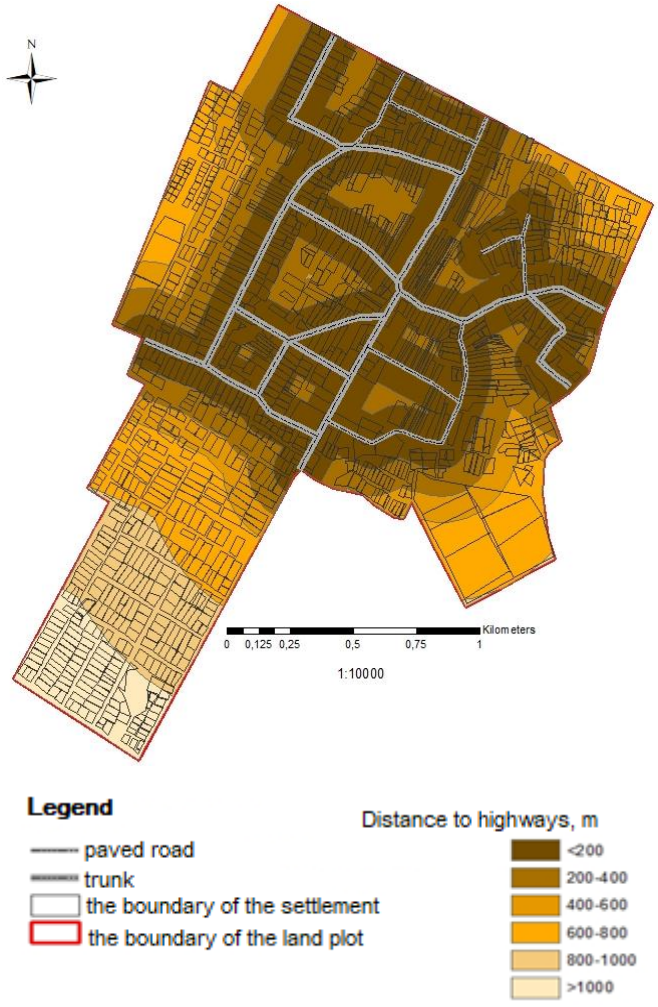


Fig. 14. Map of installation buffer zones by the value of local coefficients

The farther the land is from the highways, the smaller the local coefficient it will have on this basis.

Therefore, with the help of analytical operations in GIS, it is convenient to calculate the normative monetary valuation, operational queries for attributes, verification of geospatial data, tools for constructing buffers, and so on.

Based on the entered data and the calculated normative monetary assessment, a map of the graphical display of the value of land plots within the settlement was created (Fig. 15).

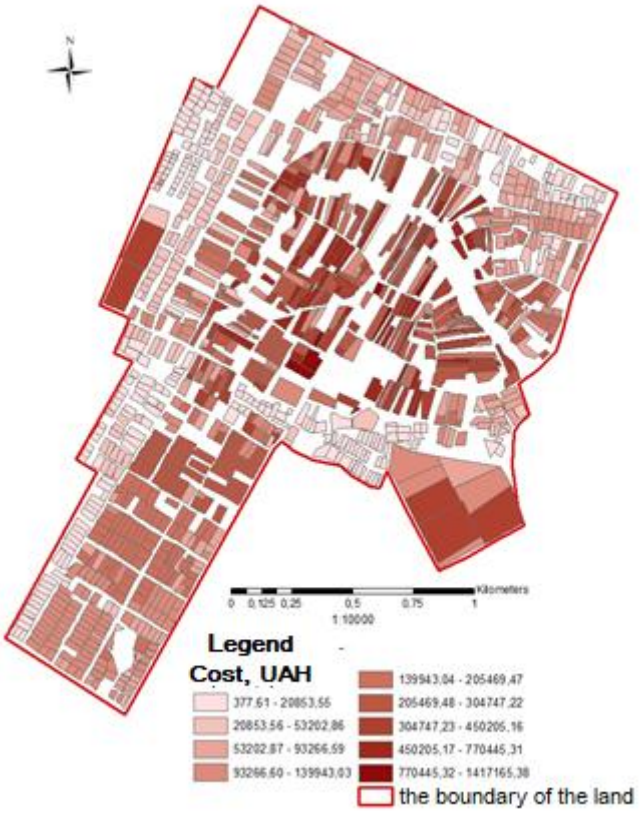


Fig. 15. Map of the value of land plots according to the results of normative monetary valuation

In accordance with the developed map, the maximum cost of land for housing and public buildings is concentrated in the central part of the village.

Similar to the maps developed above, the buffering functions used to represent the protective, coastal protection strips, as well as for a separate flood zone, which is an important factor in influencing the establishment of coefficients.

With this use of the coastal protection zone, in accordance with current legislation, a buffer with a radius of 25 m was installed (Fig. 16).

With the help of GIS tools, land plots or their parts located within the coastal protection strips were identified, this operation was performed by analyzing their vector and layered construction ("overlay"),in particular the intersection function.

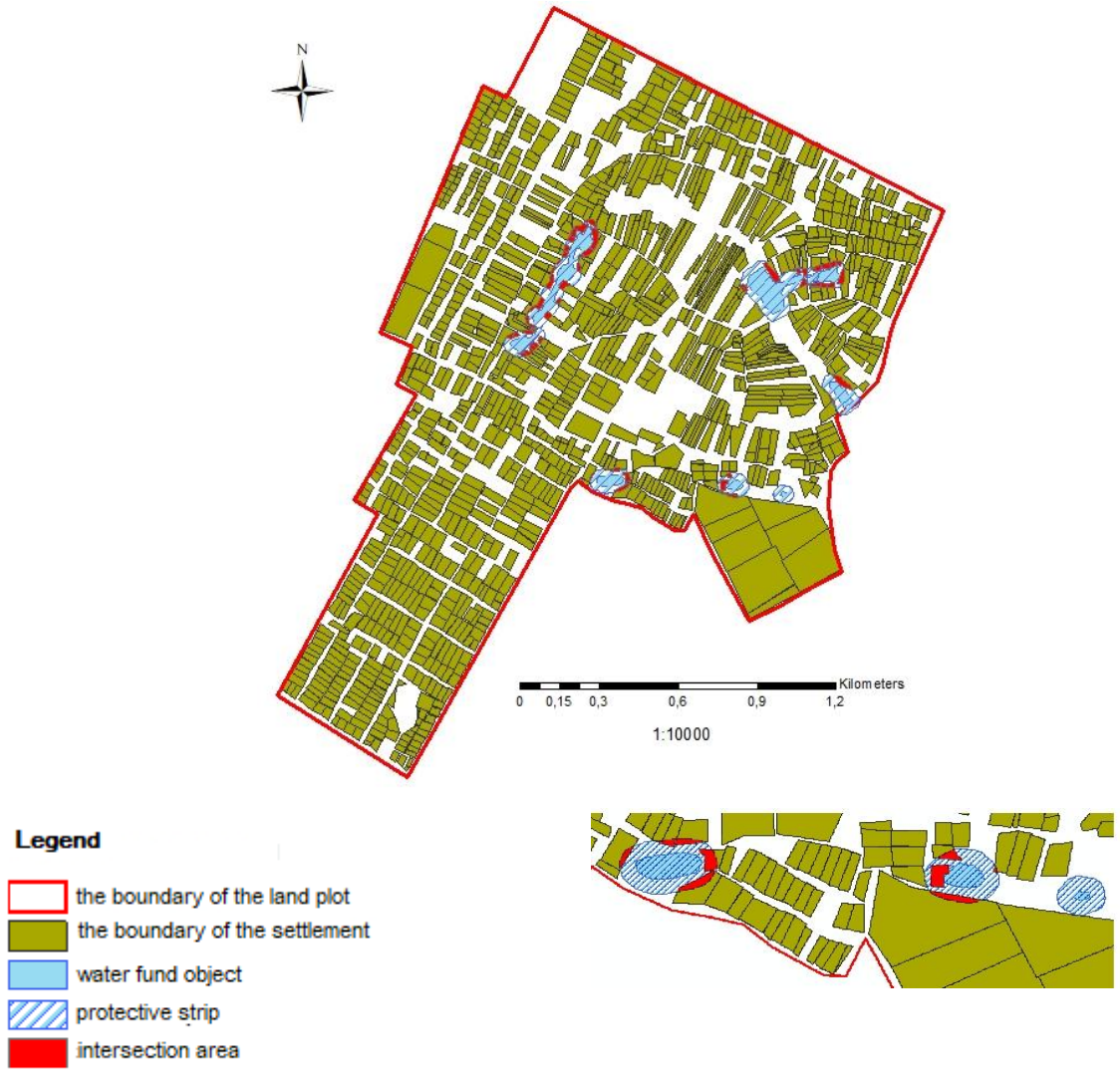


Fig. 16. Map of coastal protection strips around water bodies with allocation of zones of their intersection with land plots

The results of the geospatial analysis identified parts of land plots that are in the area of coastal protection strips around water bodies, which in this case indicates the necessary appropriateresponse of regulatory authorities is required.

Thus, the function of automated localization of parts of land plots allows state geocadastre bodies and land management departments of territorial communities to carry out operational monitoring of lands with a special legal regime of use.

It is obvious that on certain plots of land there should be a regime for land use (restriction codes 05.01 and 05.02).

Conclusions and prospects. In Ukraine, 17.06. 2021, The Law of Ukraine "On Amendments to Certain Legislative Acts of Ukraine on Land Use Planning" is in force, as it provides a combination of land management and urban planning documentation in the form of a "Comprehensive Spatial Development Plan of the territorial community" and which expands the classification of land use restrictions and changes paradigms of land resources management and land use There is an urgent need to develop and use during the normative monetary valuation of land settlements geographic information systems that provide automation of results and their prompt updating.

The given estimation algorithm allows to carry out with high accuracy normative monetary estimation of settlements, to carry out automation of updating for a certain date, to support the necessary information for inquiry, to carry out analytical operations and construction of specialized estimation maps, providing performance of fiscal functions.The use of approaches and the versatility of the use of the obtained data during the development of the land assessment GIS database testify to the expediency of spreading such systems at the levels of territorial communities, and further on the lands of all communities. The use of data formats in the development, the relative ease of work and the ability to integrate this database with systems of other types of cadastres, create a conclusion about the prospect of disseminating the presented example of its practical implementation.

In addition, similarly developed databases in combination with virtually unlimited capabilities of different types of analysis will determine the most effective types of land use for individual regions of the state, which will ultimately help optimize the process of land management.

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РАЗРАБОТКА И ИСПОЛЬЗОВАНИЕ БАЗЫ ДАННЫХ ГИС ДЛЯ ЗАДАЧ НОРМАТИВНОЙ ДЕНЕЖНОЙ ОЦЕНКИ ЗЕМЕЛЬ НАСЕЛЕННЫХ ПУНКТОВ

Аннотация. *В работе представлены результаты исследований разработки базы данных ГИС для задач нормативной денежной оценки земель населенных пунктов и отражены прикладные аспекты ее использования на примере села Личанка, Дмитровской территориальной громады, Бучанского района, Киевской области.*

Представлен алгоритм разработки базы данных ГИС для проведения нормативной денежной оценки земель населенного пункта. Представленный алгоритм оценки позволяет с высокой точностью проводить нормативную денежную оценку населенных пунктов, осуществлять автоматизированное обновление на определенную дату, получать необходимую информацию по запросу, проводить аналитические операции и построение специализированных оценочных картосхем.

Разработка базы ГИС предполагала выполнение двух этапов. На первом этапе формирования исходной земельно-оценочной базы в атрибутивную таблицу были занесены данные с Публичной кадастровой карты Украины о земельных участках в пределах населенного пункта по следующим позициям: кадастровый номер земельного участка, площадь, га, форма собственности, целевое назначение и функциональное использование земельного участка , номер кадастровой зоны, в которой находится каждый земельный участок, номер земельно-оценочного района населенного пункта, величины базовой стоимости земельных участков, значение зонального коэффициента (Км2), коэффициента, характеризующего функциональное назначение земельного участка (Кф), информацию о местоположении участка (название улицы). Второй этап предусматривал расчет величины нормативной денежной оценки

каждого из 1279 земельных участков и был выполнен за счет встроенной в среду Arc Map функции «Калькуляции числовых значений».

После завершения разработки базы данных ГИС выполнялся этап тестирования разработанной земельно-оценочной базы, который предусматривал применение разнообразных исполнений запросов, геопространственного анализа, использованием функций буферизации, топологической оверлей (сечение).

В результате проведенного анализа построены следующие картосхемы: «Влияние локальных факторов по удаленности земельного участка от центра населенного пункта», «Влияние локальных факторов по удаленности земельного участка от магистралей», «Влияние локальных факторов по экологической ситуации», «Влияние локальных факторов по обеспеченности электроэнергией», «Влияние локальных факторов на удаленность от дорог с твердым покрытием», «Влияние локальных факторов на обеспеченность централизованным водоснабжением», «Влияние локальных факторов на обеспеченность централизованной канализацией», «Влияние локальных факторов на обеспеченность централизованным газоснабжением», «Картосхема стоимости земельных участков по результатам нормативной денежной оценки», «Картосхема установки буферных зон по величине локальных коэффициентов», «Картосхема прибрежных защитных полос вокруг водных объектов с выделением зон их пересечения с земельными участками».

Благодаря применению имеющихся в среде ГИС специальных функций геопространственного анализа показаны примеры разработки высокоинформативных картографических материалов в виде специальных ценообразующих зонировок территории населенного пункта. Показана целесообразность применения базы данных ГИС для задач мониторинга качественного состояния земель, соблюдения их правового режима и возможности осуществления контроля выполнения фискальных обязательств владельцами земельных участков и пользователями.

Ключевые слова: *нормативная денежная оценка, база данных ГИС, геопространственный анализ, буферизация, земельно-оценочное зонирование, картосхемы.*

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РОЗРОБКА ТА ВИКОРИСТАННЯ БАЗИ ДАНИХ ГІС ДЛЯ ЗАВДАНЬ НОРМАТИВНОЇ ГРОШОВОЇ ОЦІНКИ ЗЕМЕЛЬ НАСЕЛЕНИХ ПУНКТІВ

Анотація*. В роботі представлено результати досліджень розробки бази даних ГІС для завдань нормативної грошової оцінки земель населених пунктів та висвітлено прикладні аспекти її використання на прикладі села Личанка, Дмитрівської територіальної громади, Бучанського району, Київської області.*

Наведено алгоритм розробки бази даних ГІС для проведення нормативної грошової оцінки земель населеного пункту. Представлений алгоритм оцінки дозволяє з високою точністю проводити нормативну грошову оцінку населених пунктів, здійснювати її автоматизоване оновлення на певну дату, отримувати необхідну інформацію за запитом, проводити аналітичні операції та побудову спеціалізованих оціночних картосхем.

Розробка бази ГІС передбачала виконання двох етапів. На першому етапі формування вихідної земельно-оціночної бази до атрибутивної таблиці було занесено дані із Публічної кадастрової карти України про земельні ділянки в межах населеного пункту за наступними позиціями: кадастровий номер земельної ділянки, площа, га, форма власності, цільове призначення та функціональне використання земельної ділянки, номер кадастрової зони, в якій знаходиться кожна земельна ділянка, номер земельно-оціночного району населеного пункту, величини базової вартості земельних ділянок, значення зонального коефіцієнта (Км2), коефіцієнта, що характеризує функціональне призначення земельної ділянки (Кф), інформацію про місце розташування

ділянки (назва вулиці). Другий етап передбачав обрахунок величини нормативної грошової оцінки кожної з 1279 земельних ділянок та був виконаний з допомогою вбудованої в середовище Arc Map функції «Калькуляції числових значень».

Після завершення розробки бази даних ГІС, виконувався етап тестування розробленої земельно-оціночної бази, який передбачав застосування різноманітних виконання запитів, геопросторового аналізу, використанням функцій буферизації, топологічного оверлею (перетин).

В результаті проведеного аналізу, побудовано наступні картосхеми: «Вплив локальних факторів щодо віддаленості земельної ділянки від центру населеного пункту», «Вплив локальних факторів щодо віддаленості земельної ділянки від магістралей», «Вплив локальних факторів щодо екологічної ситуації», «Вплив локальних факторів щодо забезпеченості електроенергією», «Вплив локальних факторів щодо віддаленості від доріг з твердим покриттям», «Вплив локальних факторів щодо забезпеченості централізованим водопостачанням», «Вплив локальних факторів щодо забезпеченості централізованою каналізацією», «Вплив локальних факторів щодо забезпеченості централізованим газопостачанням», «Картосхема вартості земельних ділянок за результатами нормативної грошової оцінки», «Картосхема встановлення буферних зон за величиною локальних коефіцієнтів», «Картосхема прибережних захисних смуг навколо водних об'єктів з виділенням зон їх перетину з земельними ділянками».

Завдяки застосуванню наявних в середовищі ГІС спеціальних функцій геопросторового аналізу, показано приклади розробки високоінформативних картографічних матеріалів у вигляді спеціальних ціноутворюючих зонувань території населеного пункту. Показано доцільність прикладного застосування бази даних ГІС для завдань моніторингу якісного стану земель, дотримання їхнього правового режиму та можливості здійснення контролю виконання фіскальних зобов'язань власниками земельних ділянок та користувачами.

Ключові слова: *нормативна грошова оцінка, база даних ГІС, геопросторовий аналіз, буферизація, земельно-оціночне зонування, картосхеми.*