

Cartographic and analytical assessment of land price formation depending on the physical and geographical conditions of the territory under military aggression in Ukraine

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ABSTRACT

Background. The presented study sheds light on the issue of land price formation in Ukraine as a result of military aggression in conditions of uncertainty. The research involved identifying the peculiarities of the formation of the real price of land plots in the case of concluding a purchase and sale agreement in conditions of uncertainty, depending on a complex of price-forming factors, primarily, taking into account the distance from the line of combat with intensive combat operations, geographical conditions of the territory. It has been shown that the land market under wartime conditions is effectively in a state of stagnation due to numerous risks for both sellers and buyers. The lack of clear legal regulation and the high risk of property loss lead to land purchase and sale transactions being carried out with significant restrictions, which do not meet the criteria for the full functioning of a market mechanism.

Methods. Used research methods: geospatial data analysis (kriging method), mathematical statistics, cartographic-analytical assessment. Among the main types of uncertainty, several determining factors are identified: political and military risks, instability of the legal environment, potential losses, uncertainty of the reliability (sufficient security) of the geographical location of land plots, as well as the uncertainty of the future.

Results. The sale price of land plots for various purposes exhibits dynamic and geospatial differentiation, depending on the manifestation of various determining factors: the state of the military-political and economic situation, as well as their geographical location, which generally corresponds with soil quality. It is characterized by the location of land plots within urban agglomerations of large settlements and/or under the protection of natural obstacles, such as rugged terrain or large bodies of water (lakes, rivers), which can potentially slow down a military offensive.

Conclusions. A significant influence of the remoteness of land plots for the maintenance of a residential building and farm buildings from a localized combat zone (in the period 2014-2022) was revealed, however, the distance of land plots from the combat line at a distance of 50 to 100 km had practically no effect on the formation of the purchase price - the sale of land plots, which is connected with the intensification of hostilities and the transition of the situation to a state of higher degree of uncertainty. The obtained results provide important information for planning the future development of the land market under wartime conditions and post-war recovery. They indicate the need to adapt land valuation methods considering the current military-political realities and are aimed at minimizing risks for participants in land relations. The results of the study indicate the need to make appropriate changes in the methodology of normative monetary valuation of land plots and the methodology of expert monetary valuation of land plots.

Keywords: *physical and geographical conditions, price, uncertainty, geospatial models, military aggression, land plots, cartographic and analytical assessment.*

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Introduction. It is generally known that since February 24, 2022, the armed military aggression of the Russian Federation against Ukraine has been ongoing in Europe, which has lasted for more than two years. Large-scale hostilities covered the entire territory of the state, which is waging existential

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resistance to preserve its own statehood. In the difficult conditions of military operations, Ukraine, as part of the European Commonwealth of Nations, makes efforts aimed at preventing the aggressor state from seizing new territories and keeping the economy in working condition. Under such conditions, an important feature of the stability of the economy of any state is its ability to ensure the functioning of the market of land plots for various purposes, including agricultural land. In the difficult conditions that have arisen, this allows us to solve several main tasks: to ensure that citizens and legal entities exercise their right to dispose of part of their assets (I), to contribute to the receipt of larger volumes of state duty (II) to the state budget, and to minimize the risks of property loss (monetary resources) in case of temporary short-term or long-term loss of territory (III).

This problem is especially acute in the territories near the line of contact between the Defense Forces of Ukraine and the occupying forces of the Russian Federation.

Analysis of research. To research this topic were chosen for the study of this topic, in particular, changes in the conditions of the course of hostilities and the aggravation of the political situation as a result of hostilities, which can lead to a decrease in the investment attractiveness of the region. For example, the war in Syria has led to massive destruction and population displacement, which has reduced demand for real estate and affected land prices [3].

In addition, military actions can cause significant damage to infrastructure, which plays an important role in shaping the value of land plots. For example, after the war in Afghanistan, many roads and cities were destroyed, which led to a fall in the value of land in certain areas [10].

Military conflicts lead to an economic downturn that affects the real estate market. Russia's invasion of Crimea and the conflict in eastern Ukraine led to the decline of the economy of these regions, which caused a decrease in land prices [6].

Military actions can lead to political changes that will affect the regulation of the real estate market. For example, after the war in Libya, new land ownership laws were introduced, which changed the conditions for investors and land owners [2].

Military actions, as a rule, lead to a humanitarian crisis, which negatively affects the real estate market. For example, as a result of the war in Yemen, the majority of the population found themselves in conditions of a humanitarian crisis, which caused an increase in prices for residential real estate and land plots [4].

In addition, the land market is influenced by a number of other factors, including psychological factors such as fear and uncertainty associated with

war, which often make people postpone the purchase of real estate, which leads to a decrease in prices. In addition, the growth of emigration from war zones reduces the demand for housing and other real estate. However, war can also lead to increased demand for housing in safe areas, leading to higher property prices in these areas [9].

Repurposing is another important aspect. War can prompt the repurposing of land, for example from agricultural to industrial, which can increase its value if the new purpose turns out to be more profitable [5]. In addition, the destruction or damage of real estate objects can lead to their transition to the category of land plots, which can reduce their value).

Legal aspects of price formation are also of great importance. Changes in legislation regulating the real estate market under the influence of war can significantly affect real prices. Moreover, increased risks associated with real estate investing in war zones may lead to higher mortgage interest rates, which negatively affects demand [11].

International organizations can also influence market dynamics. Financial assistance from such organizations to restore infrastructure and housing stock can stimulate demand for real estate and increase prices. On the other hand, the introduction of sanctions against countries that are waging war can have a negative impact on their economies and, accordingly, lead to a drop in real estate prices [15].

A specific, but no less significant influence on the formation of the value of land plots and real estate objects in the conditions of military aggression is caused by localization within large urban agglomerations, as well as a favorable geographical position in relation to the lines of combat confrontation. It is about the location of territories with existing real estate under the protection of natural obstacles significant for military aggression: mountain systems, large rivers, forested areas, swamps and wetlands, irrigation and drainage systems, deserts and difficult terrain conditions [16].

Finally, long-term consequences must be considered. The effects of war on the real estate market can be felt for years after hostilities end. The restoration of destroyed infrastructure and housing stock can take a long time and require a lot of effort. In addition, changes in the political and economic situation in the country can lead to long-term changes in the real estate market [19].

That is why in this work, considerable attention is paid to the study of the formation of sales prices of land plots of various purposes within the territory of 8 regions of Ukraine, where hostilities continued and the land market functioned.

The purpose of the research is to identify the peculiarities of the formation of the real price of

land plots in the case of a purchase and sale agreement, depending on the complex of price-forming factors, primarily, taking into account the distance from the line of combat with intensive combat operations, geographical conditions of the territory.

The **object** of the research is a cartographic and analytical assessment of the main factors of price formation in the conditions of military aggression, the geospatial distribution of the price of land plots of various purposes in relation to the location of the established line of combat confrontation in the period 2021-2023, taking into account the influence of the geography of the territory and proximity to large population centers.

The subject is a study of the impact of key price-forming factors, such as geographic location, distance from the war zone, the presence of natural obstacles and the location of land plots of various purposes in the area of urban agglomerations on the formation of sales prices using methods of geospatial analysis and cartographic-analytical data evaluation.

Research tasks included:

- carrying out a literary and analytical review on the topic of research;
- development of a GIS database with information on purchase and sale agreements of land plots for various purposes for the period 2021-2023;
- development of land evaluation geospatial models of differentiation of the value of land plots per unit of area of different purpose in 8 oblasts of Ukraine with a display of the line of combat collision;
- cartographic and analytical assessment of the formation of the price of land plots in relation to the line of combat confrontation, taking into account the characteristics of the territory.

Research method. Research method of Geospatial Data Analysis (kriging method), mathematical statistics, cartographic-analytical assessment. Resources: DeepState [18], State Service of Ukraine for Geodesy, Cartography and Cadastre, GISData [8] (magneticonemt) – as a cartographic basis and formation of a GIS database.

Research results. After the invasion of troops, there was a relative stabilization of the line of combat engagement (LCE) [1]. The specified location of the LCE was used for the cartographic-analytical assessment of the geospatial distribution of the formation of the price of land plots of various purposes, depending on various determining factors.

It is clear that the temporary fixation of the location of the troops creates certain conditions of uncertainty - the expectation of a possible breakthrough of the enemy's troops or, on the contrary, a decrease in the probability of its implementation. For citizens, conditions of uncertainty consist in the

impossibility of disposing of their right to sell a plot of land.

In such a situation, the uncertainty for citizens will be too high, and certain aspects of it can be formalized in the form of the corresponding types of risks, which are listed below.

The risks of an unstable legal environment arise when property rights and legal regulations can be extremely unstable in the context of hostilities that continue at some distance from the location of the properties, creating additional uncertainty for potential sellers.

The risks of potential losses in a military conflict can result in significant losses because the market price can change dramatically due to the potential danger of destruction or destruction of the property.

The risks of the uncertainty of the future after a military conflict can be unpredictable, and people (potential participants in real estate transactions) can be in conditions of uncertainty regarding the future of property, the economic development of the region, and political conditions. As a result, the above creates additional difficulties in the case of making decisions about the sale of land plots.

The risks of uncertainty of the reliability (security) of the geographical position. The location of land plots in the middle or outside the boundaries of urban agglomerations of large settlements or under the protection of natural obstacles in the form of rough terrain, large water bodies (lakes, rivers), which can potentially slow down the military offensive and increase the price of annexing the territory for the enemy, may have a significant influence on the formation of their price, mainly in the short- or medium-term perspective [13].

Taking into account modern military aggression, which is considered by experts to be a hybrid, the location of a plot of land in the zone of potential flooding of water bodies should be considered a negative characteristic, because it potentially increases the danger of deterioration of its condition, which is proved by the fact of undermining the Kakhovskaya Dam by Russian troops.

Therefore, in the conditions of military conflict and occupation, the uncertainty for citizens who intend to sell land plots can be very significant, which will require a more careful consideration of all possible risks and consequences [20].

To solve the research tasks, a GIS database has been developed, which contains: the code of the settlement (KOATUU), the area of the settlement, the name of the settlement, information on regional subordination, belonging to the pre-territorial community, data on the price of land plots of various purposes in the period from 2021-2023 years [12, 14].

The differentiation of the price of land plots of different purposes varied over the years, depending on the development of the military invasion on the territory of Ukraine (Table 1).

The year 2021 was chosen as the base year for

comparative characteristics and cartographic-analytical assessment of land price changes, when the real estate market in Ukraine was in a state of relative stability, despite the negative impact of the pandemic Covid 19.

Table 1

Chronology of Russia's military invasion of Ukraine.

The main stages of the development of military actions that changed the location of the contact line and directly or indirectly influenced the formation of the price of the sale of land plots

Date of the research period	Event	Direction and status of the event
24 Feb - 2 Mar, 2022	The beginning of a full-scale invasion of Russia into Ukraine. The Russian army partially occupied Kyiv, Sumy, Chernihiv, Zaporizhzhia, Kharkiv and Kherson regions	military, negative
2 Apr - 15 Jun, 2022	Liberation by Ukraine of Kyiv, Kharkiv, Sumy, Chernihiv, Zaporizhzhia, Kharkiv, and partially Kherson regions	military, positive
24 Jun - 3 Jul, 2022	The APU left Severodonetsk and Lysychansk	military, negative
6 Sep, 2022	The beginning of the Kharkiv counteroffensive. In the first days, about 6,000 square meters were released. km of the territory of Ukraine and almost the entire Kharkiv region	military, positive
23 Sep - 3 Oct, 2022	In order to formalize the annexation of the territories of Ukraine, the aggressor held illegal pseudo referendums on the accession of the Kherson, Zaporizhzhia, Donetsk and Luhansk regions to Russia	military, negative
11 Nov, 2022	Liberation of Kherson by Ukraine	military, positive
25 Jan, 2023	Russian troops captured Soledar	military, negative
8 Jun, 2023	The beginning of the summer counteroffensive of the Armed Forces of Ukraine and the partial liberation of the territories of the Zaporizhzhia region	military, positive
10 Oct, 2023	The Russian occupiers launched a massive offensive in the Avdiyivka area	military, negative

The change in the price values of the area of land plots of three main types of purpose was studied: 02.01 - for the maintenance of a residential building and farm buildings (homestead), 01.01 - for the conduct of commercial and agricultural production, and 01.03 - for the conduct of a personal peasant farm. The pre-war year 2021 was chosen as the base year of pricing for the formation of its values.

It should be noted that the current methods of monetary valuation of land plots, both normative and expert, do not contain norms that take into account the impact of military actions on the price of a land plot, although military aggression has been ongoing since 2014.

It is no coincidence that the lowest price of land plots for the maintenance of a residential building and farm buildings was recorded in 2021 in the eastern part of Ukraine. On geospatial models, these are parts of the Kharkiv, Luhansk, and Donetsk regions (Fig. 1).

The lowest, too low and low price of land plots in the specified locations is due to the fact that military operations took place near the specified territo-

ries, which actually continued in the east of Ukraine since 2014.

Their price gradually increased in the northern and southern directions along the combat contact line (ATO zone), which was formed after 2014 and reached maximum values in the agglomerations of large cities - Dnipro, Mykolaiv, Odesa, Kherson and Zaporizhzhia (see Fig. 1 "A").

The geospatial differentiation of the sale price of land plots, depending on the distance from the war zone, indicates that its formation took place under the influence of subjective factors, in particular, during the conclusion of the purchase and sale agreement. In the final result, the revealed regularity indicates the need to revise the existing methods of normative and expert monetary valuation of land plots in Ukraine.

After a full-scale invasion in February 2022 of land plots for the construction of a residential building and the maintenance of farm buildings, it actually ceased to function, as evidenced by the absence of agreements on the purchase and sale of plots.

The highest values of the price of land plots for

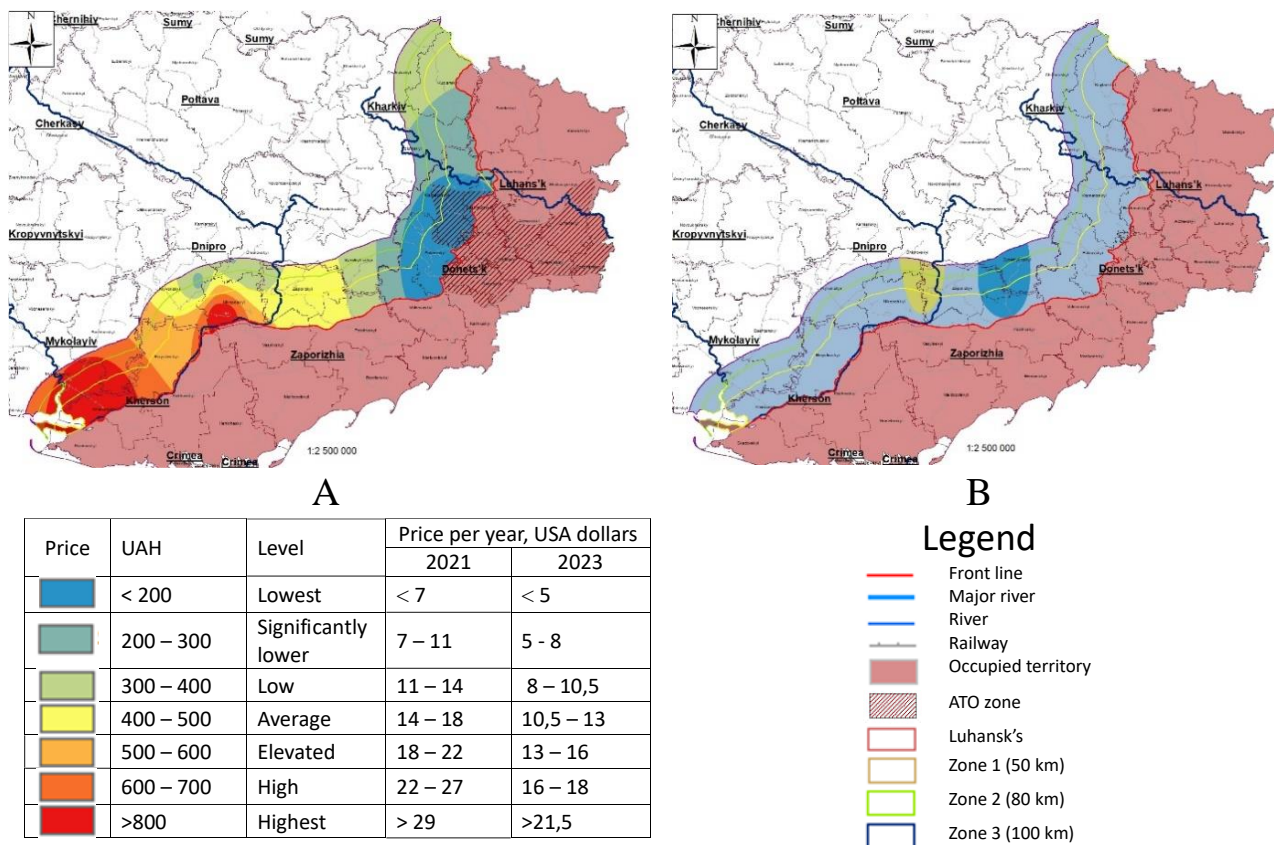


Fig. 1. The cost of 1 hectare of land for the construction of a residential building and maintenance of outbuildings: A - 2021, B - 2023.

the maintenance of a residential house and commercial buildings are observed in the agglomeration of the cities of Odesa, Mykolaiv, and Kherson, which are close to the northern coast of the Sea of Azov. The last feature is related to the possibility of transferring these plots to short-term rentals during the holiday season, which increases their price due to their recreational appeal.

However, compared to the base year of 2021, in 2022 - 2023, the sale price of plots for the construction of a residential building and maintenance of commercial buildings in the dollar equivalent decreased significantly. On average, by 30%, which indicates the depreciation of residential real estate as a result of military aggression.

The value of the price of most plots is close to the normative monetary value (NMV), below which its formation is prohibited by law, which is due to the need to pay state duty on each purchase and sale agreement. The vast majority of agreements were concluded in the circumstances of multi-vector uncertainty, which creates correspondingly complex conditions for the formation of its values.

Under such circumstances, none of the conditions for compliance with the term "market value" were fulfilled, which, as is known, is the value for which the object of assessment can be sold on the market of similar property on the date of assessment

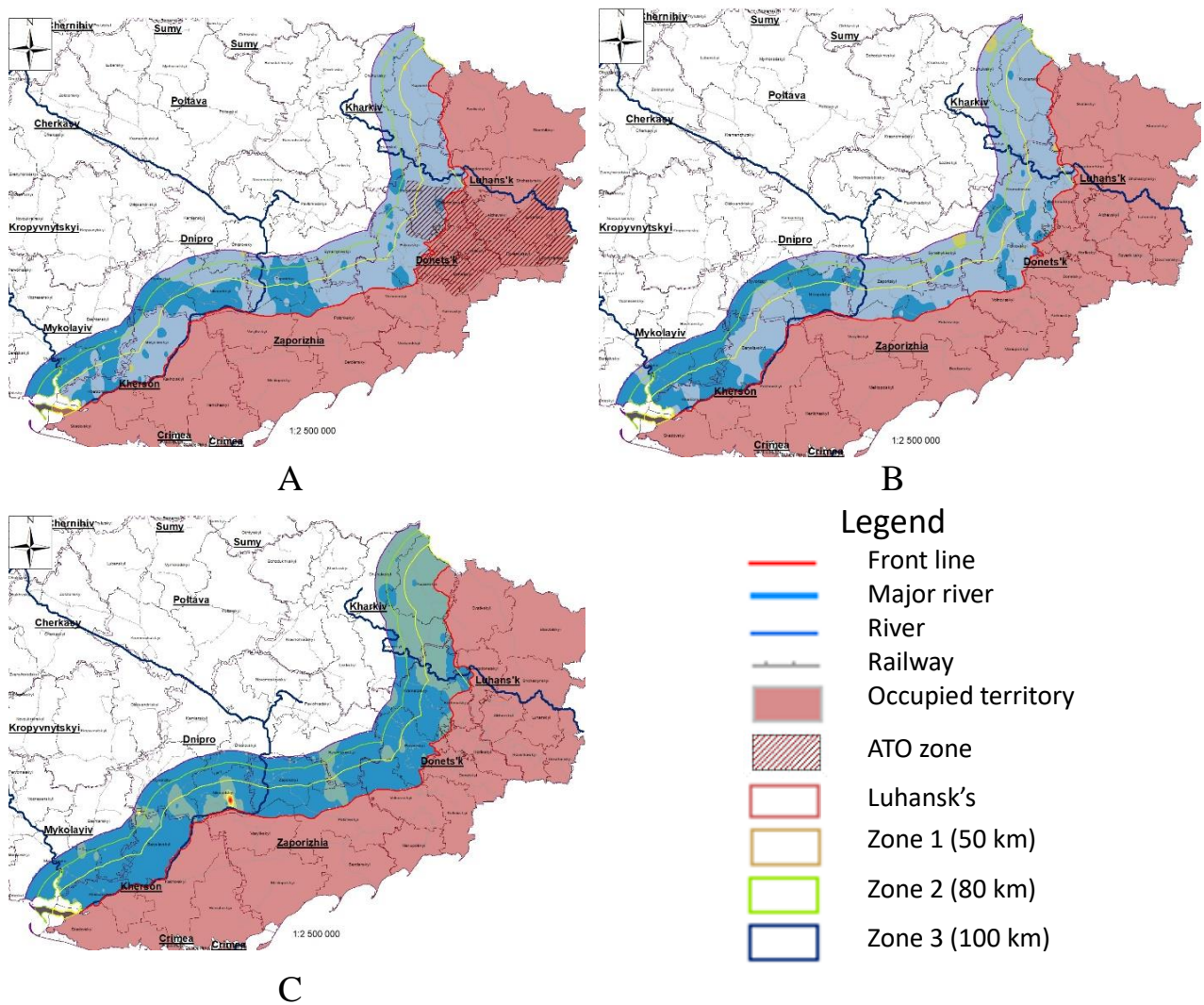
according to the agreement concluded between the buyer and the seller. One of the main factors in the formation of an objective price, as is known, is that each of the parties to the agreement acts with knowledge of the matter, judiciously and without coercion, which is impossible in the conditions of military aggression [16]. And the functioning of the market of land plots and real estate objects in the complex conditions of uncertainty that have developed should be considered conditional.

A radically different picture in price formation is observed for plots with the target purpose of 01.03 - for commercial agricultural production (Fig. 2).

According to the results of the conclusion of agreements for the purchase and sale of land plots for commercial agricultural production, the price of the agreements in 2021 and in 2022 after the restoration of the land market turned out to be little variable (see Fig. 2).

The geospatial differentiation of the decline in land sales prices is generally consistent with a decline in soil fertility in a northeast-southwest direction along the long-term stabilized battle line. The value of prices is relatively stable and remained with little change until the beginning of 2024 (see Figs. 1A and 2A).

The soil map of Ukraine according to the FAO classification is shown in Figure 3.



Price	UAH	Level	Price per year, USA dollars		
			2021	2022	2023
	< 33 000	Lowest	< 1 213	< 890	< 890
	33 000 – 58 000	Significantly lower	1 210 – 2 130	890 – 1 570	890 – 1 560
	58 000 – 83 000	Low	2 130 – 3 050	1 570 – 2 250	1 560 – 2 230
	83 000 – 108 000	Average	3 050 – 3 970	2 250 – 2 920	2 230 – 2 910
	108 000 – 133 000	Elevated	3 970 – 4 880	2 920 – 3 600	2 910 – 3 580
	133 000 – 159 000	High	4 880 – 5 840	3 600 – 4 300	3 580 – 4 280
	> 184 000	Highest	> 6 760	> 4 980	>4 960

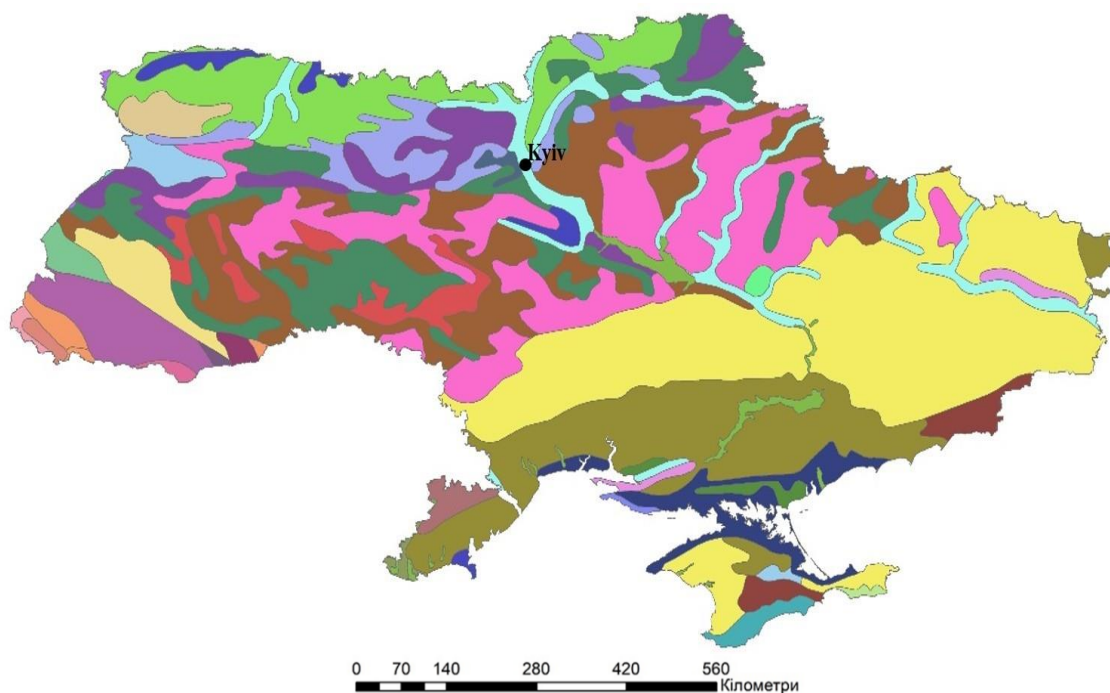
Fig. 2. The cost of 1 hectare of land for commercial agricultural production: A - 2021, B - 2022, C - 2023

The codes and names of soils according to the FAO classification are provided in the table 2.

The predominant soil type along the front line is chernozem—one of the most valuable soils in the world, differentiated by types and manifestations of dominant processes, such as salinization, solonchization, and gleying. The following soils are prevalent along the front line: Ck10-2ab – Calcaric

Cambisols, C112-2ab – Chromic Luvisols, C113-2a – Chromic Luvisols, D/SS – Dunes and Shifting sands, Ch22-2a – Chernozems, Jc49-1/3a – Gleyic Phaeozems [7].

Overall, the identified feature of the geospatial distribution of land sale prices is logical, as the methodology for their expert monetary valuation takes into account the bonitet score of Ukraine's ag-



Soils of Ukraine					
	Bd66-1/2bc		De18-1a		Jc61-a
	Bd72-2b		De18-2a		Je87-2/3a
	Be12 Be122-2bc		De19-2a		Kh1-2a
	Be123-2b		De20-2ab		Kh31-2a
	Ch22-2a		Gh23-3a		Kh33-2a
	Ch5-2a		Gm14-2/3a		Kh34-2a
	Ck10-2ab		Gm30-2/3a		Lg41-2/3ab
	Cl12-2ab		Hg7-3a		Lg54-1a
	Cl13-2a		I-Be-2c		Lg55-1a
	D/SS		Jc49-1/3a		Lo89-2a

Fig. 3. Soils of Ukraine according to FAO classification [7]

Table 2

Codes and names of soils of Ukraine according to the FAO classification

Bd	Dystric Cambisols	Hg	Gleyic Phaeozems	Od	Dystric Histosols
Be	Eutric Cambisols	L-Be Lithosols	Lithosols-Eutric Cambisols	Pi	Leptic Podzols
Ch	Haplic Chernozems	Jc	Calcaric Fluvisols	Po	Orthic Podzols
Ck	Calcic	Je	Eutric Fluvisols	So	Orthic Solonetz
Cl	Luvic Chernozems	Kh	Haplic Kastanozems	We	Eutric Planosols
De	Eutric Podzoluvisols	Lg	Gleyic Luvisols	D/SS	Dunes and Shifting sands
Gh	Humic Gleysols	Lo	Orthic Luvisols	WAT	Inland Waters
Gm	Mollic Gleysols	Mo	Orthic Greyzems		

gricultural soil groups. The decrease in soil fertility is associated with the reduction in soil moisture levels.

Localization of zones of "high" and "high" sales prices of land plots for commercial agricultural production is observed in the direction west of the

city of Zaporizhzhia, which is conditionally protected from the east by the Dnipro River and a cascade of reservoirs, which in fact are practically impassable natural obstacles to traffic troops of the aggressor. Therefore, this localization is natural, and water

bodies represent an additional positive factor in pricing. Whereas in peacetime, the location of land plots in a potential flooding zone is a significant factor that lowers the price. Therefore, military actions can lead to a change in the pricing of land plots.

The influence of the distance from the battle line on the formation of the sales price of land plots for commercial agricultural production at distances of 50, 80 and 100 km was not found.

After the liberation of a large part of the occupied territory of Ukraine in the fall of 2022 and the relative stabilization of the land market for various purposes, in 2023 there was an increase in the sale price of plots for commercial agricultural production in all regions except Zaporizhzhia, Dnipropetrovsk, and Kharkiv regions (Fig. 4).

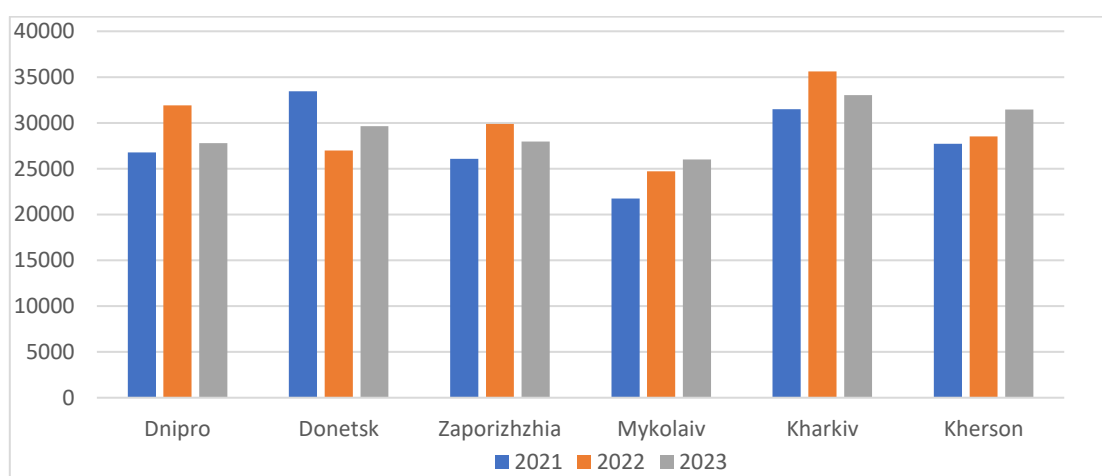


Fig. 4. The average price of 1 hectare of land for commercial agricultural production

Note that despite the fact that the regional center of the Kherson region is actually on the collision line, the price of plots has increased, including in the territory of the Kherson region. This indirectly confirms the positive protective influence of the great Dnipro River. It is about reducing the danger of occupation of other communities in the region, located north of the water body. It serves as a significant military natural obstacle for the potential penetration of the aggressor's troops, therefore it has a positive effect on the formation of the price of land plots.

The sale price of plots of land for personal farming after the start of Russia's military aggression in 2022-2023, compared to the base year of 2021, in hryvnia equivalent increased in the territory of all regions within the studied zones (Figs. 5,6). Instead, the corresponding values in the dollar equivalent decreased significantly.

The activation of the land market and the marked increase may be related to the increase in the demand of individuals, as well as legal entities, for land plots of personal peasant farms and the fact

This is explained by the fact that against the background of military operations, the number of offers of land shares (shares) for sale exceeded the number of needs, because the risks of property loss in the event of the movement of invading troops were too high.

In addition, in the legislation of Ukraine there is a legal norm of priority purchase by the tenant of the leased land plot (land share - share) in case of the owner's decision to sell it. That is why one of the main determining factors of the too low sale price of land plots is the restriction of the owners regarding the right of disposal, which was not changed due to the lack of time during the war. In addition, the adoption of a decision on the alienation of land plots is carried out under strict conditions of multi-vector uncertainty.

that the vast majority of them were not leased and were used by the owners directly.

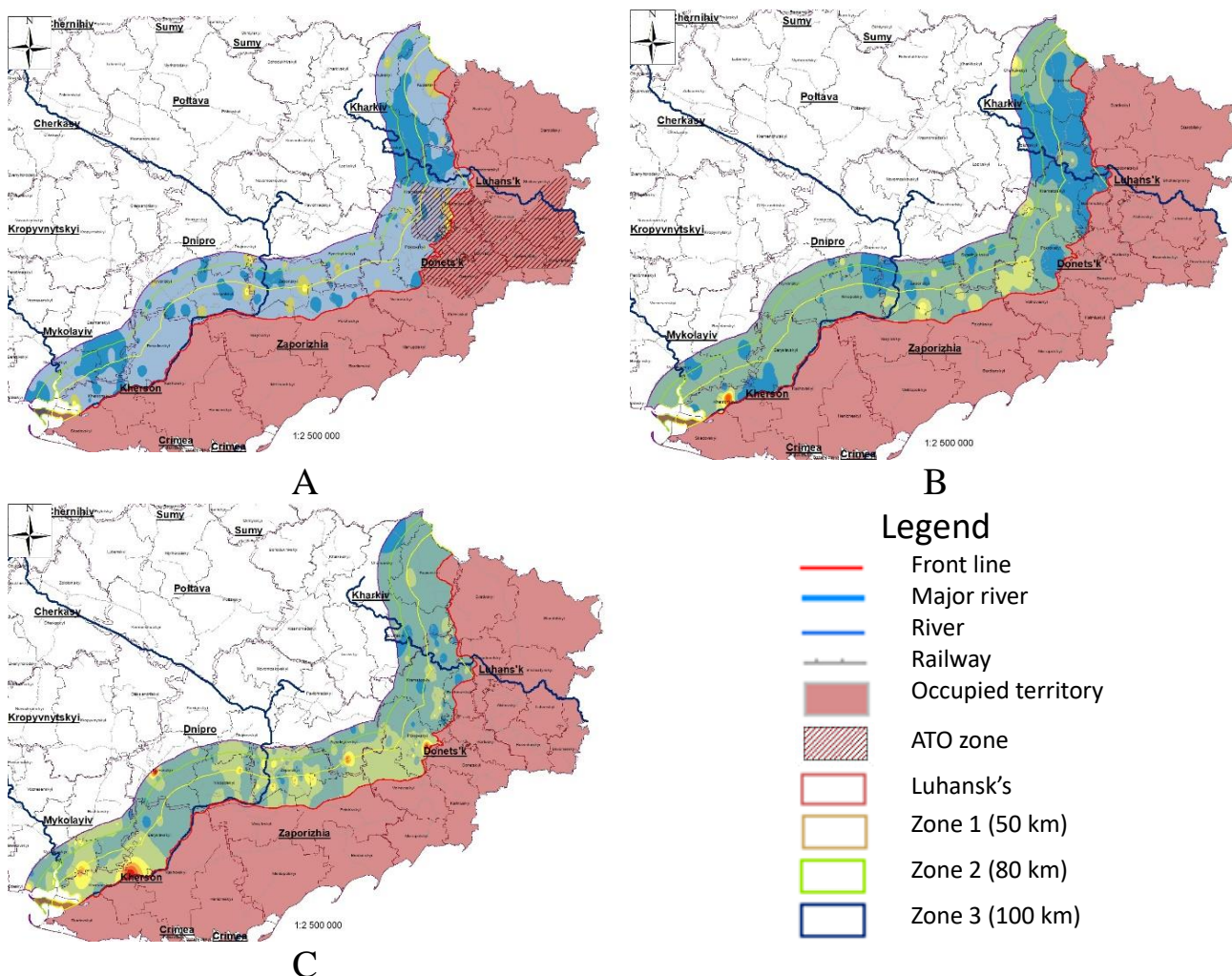
In addition, there was a partial return of internally displaced persons (IDPs) who resumed the use of their assets, due to which the supply of land plots decreased, compared to the beginning of military aggression, the observed dynamics of the land market is largely probable.

The increase in the value of plots for personal farming is particularly noticeable due to a significant increase in the price of purchase and sale agreements in 2023, compared to 2024 (see Fig. 6).

On the other hand, in 2022-2023 compared to 2021, there is a decrease in the values of the price of land plots (in dollar terms). The decrease is on average from 26.6% to 30.0%, which may indirectly indicate the deterioration of the economic situation in the state and the increase of risks of various nature.

In particular, it is about the lack of guarantees from the state regarding the territorial integrity of its individual parts and the potential change of owners of land plots.

In addition, there is a high danger of changing



Price	UAH	Level	Price per year, USA dollars		
			2021	2022	2023
	< 14 000	Lowest	< 500	< 370	< 350
	14 000 – 28 000	Significantly lower	500 – 1 030	370 - 750	350 - 750
	28 000 – 42 000	Low	1 030 – 1 540	750 – 1 130	750 – 1 150
	42 000 – 56 000	Average	1 540 – 2 050	1 130 – 1 500	1 150 – 1 500
	56 000 – 70 000	Elevated	2 050 – 2 570	1 500 – 1 890	1 500 – 1 880
	70 000 – 84 000	High	2 570 – 3 080	1 890 – 2 270	1 880 – 2 260
	> 98 000	Highest	> 3 600	> 2 655	>2 650

Fig. 5. The cost of 1 hectare of land for personal farming: A - 2021, B - 2022, C - 2023

the general mode of economic functioning of subjects of economic activity on lands located in the immediate vicinity of the demarcation line. Buying an agricultural plot of land, which is located near the military demarcation line of two countries, may carry additional risks for the buyer, which are listed below.

Active hostilities entail a high risk of coming under fire or other military action. Uncertain in time is the danger of damage to the soil cover, which is the main means of production in agriculture.

Military and government bodies can restrict access to certain territories, which will lead to a change in their functioning regime, primarily in the context of limiting economic activity.

Due to the danger and uncertainty, the value of such a plot may decrease significantly. Lands and real estate objects may require significant investment for recovery after hostilities (mining, restoration of damaged soils and infrastructure).

In addition, there may be controversial issues regarding the uncertainty regarding the outcome of

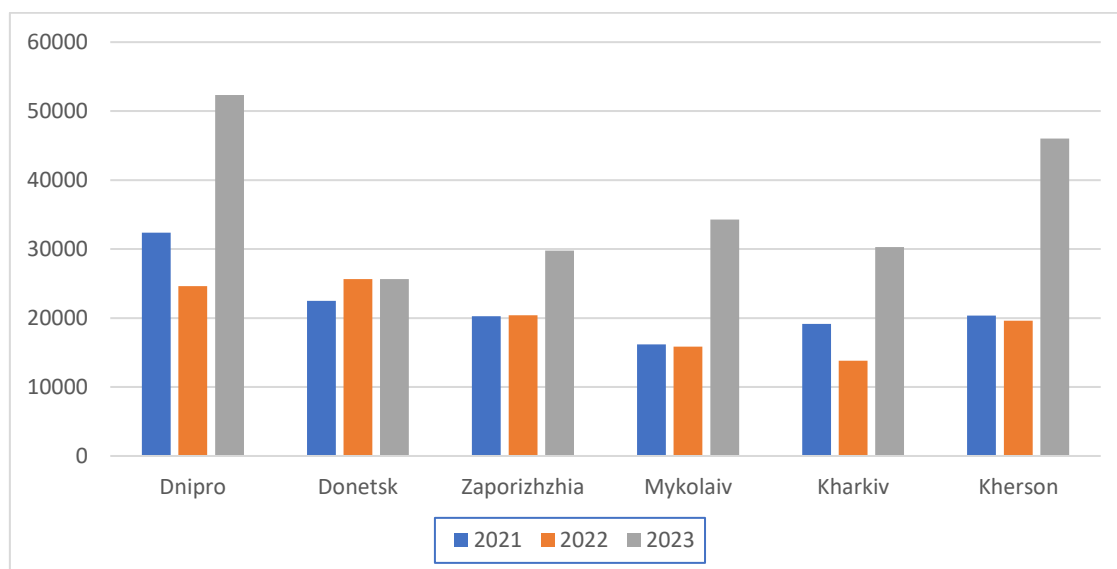


Fig. 6. The average price of 1 hectare of land for personal farming

the end of the military conflict, and as a consequence the increased danger of using real estate as a resource for reparations and compensations.

The local population may be negatively disposed to the new owners due to the aggravated situation.

Possible damage to roads, power grids, water supply and other infrastructure elements is likely, which will increase the cost of production.

As a result, a significant decrease in the receipts of both internal and external investment resources, deterioration of logistics connections with product sales markets is also expected.

In general, the market of land plots, which are located in relative proximity to the battle line and are in conditions of significant uncertainty, is actually in a state of certain stagnation. The formation of the sale price of land plots of the researched types of purpose is under the influence of a significant number of potentially perceptible determining factors. Among them, political uncertainty, the lack of a clear understanding of the future by participants in the land market, the imperfection of the existing legislation regulating the purchase and sale of plots for commercial agricultural production (in conditions of war) are prominent among them.

Considering the above, potential buyers should carefully evaluate all the mentioned risks, consult with experts before making a decision to buy a plot of land near the military demarcation line.

Conclusions. This study presents the results of research on the cartographic and analytical assessment of land price formation in Ukraine, depending on the physical and geographical conditions of the territory under military aggression.

Based on a literature and analytical review, it was established that the formation of land sale prices for three main land use categories-namely, 02.01

for the maintenance of residential and household buildings (homestead), 01.01 for commercial agricultural production, and 01.03 for personal farming-occurs under the complex influence of determining factors of political, economic, military, geographical, and other origins.

Among the main types of uncertainty, several determining factors were identified: political and military risks, instability of the legal environment, potential losses, uncertainty about the future, and uncertainty regarding the reliability (sufficient security) of the geographical location of land plots.

The study revealed that land sale prices for various purposes exhibit dynamic and geospatial differentiation, depending on the manifestation of different determining factors, such as the state of the military-political and economic situation, and their geographical location, particularly regarding soil cover. It was found that land prices are influenced by the location of land plots within urban agglomerations of large settlements and/or under the protection of natural obstacles, such as rugged terrain or large water bodies (lakes, rivers), which can potentially slow down military advances.

It was determined that the distance of land plots from the established combat line at 50, 80, and 100 km had little to no effect on land sale prices.

A significant influence was found regarding the distance of residential and household building plots from localized combat zones formed between 2014 and 2022. It was proven that land prices increased in the northern and southern directions along the combat line (ATO zone), which formed after 2014, reaching peak values in the agglomerations of large cities such as Dnipro, Mykolaiv, Odesa, Kherson, and Zaporizhzhia.

On the other hand, it was established that the presence of rivers, reservoirs, and other water bodies

in land price formation exerts an indirect protective influence and acts as a positive factor (increasing value).

Price ranges for land sales by year were established. In 2021, prices for residential building and household maintenance land ranged from \$7.0 to \$29.0 or more per 100 m²; for commercial agricultural production, from \$1,213 to \$6,760 or more per hectare; and for personal farming, from \$500 to \$3,600 or more per hectare. In 2022, the market for residential building and household maintenance land ceased to function; for commercial agricultural production, prices ranged from \$890 to \$4,980 or more per hectare; and for personal farming, from \$370 to \$2,655 or more. In 2023, prices ranged from \$5.5 to \$11.0, 890 to 4,960 UAH, and \$350 to \$2,650 respectively (per 100 m² and 1 hectare), which overall reflects a significant deterioration in Ukraine's economic climate and increased risks associated with

land sales transactions. Buyers of land plots face potentially higher risks, while sellers bear one-time financial losses.

The results indicate a general trend of changes in land prices across different regions of Ukraine. In particular, in Kharkiv, land prices for commercial agricultural production in 2022 reached their maximum value during the research period, while land for personal farming in the same region had its lowest values that year. Similar trends were observed in Zaporizhzhia and Dnipropetrovsk regions.

However, their price policies for land sales for different purposes vary significantly. For example, in Donetsk, the maximum land price for commercial production was recorded in 2021, while in Kherson, it was in 2023. In Mykolaiv, there was a gradual increase in prices for land for commercial production, while for personal farming, the maximum value was in 2023, and the minimum was in 2022.

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Картографо-аналітична оцінка формування цін на земельні ділянки залежно від фізико-географічних умов території внаслідок військової агресії в Україні

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Представлене дослідження висвітлює питання формування ціни земельних ділянок в Україні внаслідок військової агресії в умовах невизначеності. Виконання досліджень передбачало виявлення особливостей формування реальної ціни земельних ділянок у випадку заключення угоди купівлі-продажу в умовах невизначенос-

ті, залежно від комплексу ціноутворюючих чинників, в першу чергу, з урахуванням віддаленості від лінії бойового зіткнення з інтенсивними бойовими діями, географічними умовами території. Відсутність чіткого правового регулювання і високий ризик втрати майна зумовлюють укладання угод купівлі-продажу земельних ділянок з суттєвими обмеженнями. Використані методи досліджень: геопросторового аналізу даних, математичної статистики, картографо-аналітичної оцінки. Серед основних видів невизначеності ідентифікують декілька зумовлюючих чинників: політичні та військові ризики, нестабільність правового середовища, потенційні збитки невизначеність надійності (достатньої захищеності) географічного положення земельних ділянок, а також невизначеність майбутнього. Ціна продажу земельних ділянок різного цільового призначення має динамічну та геопросторову диференціацію, залежно прояву різних зумовлюючих чинників: стану військово-політичної, економічної ситуації та географічного їх розташування, яке в цілому узгоджується з якістю ґрунтів, характеризується місцезнаходженням земельних ділянок в середині міських агломерацій великих населених пунктів та/або під захистом природних перешкод у вигляді пересіченої місцевості, великих водних об'єктів (озер, річок), які потенційно можуть уповільнювати військовий наступ. Виявлено суттєвий вплив віддаленості земельних ділянок для обслуговування жилого будинку та господарських будівель від локалізованої зони бойових дій (у період 2014 - 2022 рр.), однак віддаленість земельних ділянок від лінії бойового зіткнення на відстані від 50 до 100 км практично не впливала на формування ціни купівлі-продажу земельних ділянок, що пов'язано з активізацією бойових дій та переходом ситуації у стан вищого ступеня невизначеності. Отримані результати надають важливу інформацію для планування перспектив розвитку ринку землі в умовах війни і післявоєнного відновлення, вказують на необхідність адаптації методів оцінки вартості землі з урахуванням наявних військово-політичних реалій. Результати дослідження вказують на необхідність внесення відповідних змін в методику нормативної грошової оцінки земельних ділянок та методику експертної грошової оцінки земельних ділянок.

Ключові слова: *фізико-географічні умови, ціна, невизначеність, геопросторові моделі, військова агресія, земельні ділянки, картографо-аналітична оцінка.*

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