

GeoTerrace-2026-016**Spatial Analysis of Housing Price Dynamics under Wartime Risk Conditions: A Case Study of Kharkiv (2021–2025)**

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SUMMARY

The full-scale war in Ukraine has brought about fundamental changes in the functioning of the residential real estate market, making security-related factors significant determinants of housing value. In cities located near active combat zones, spatial differences in housing prices have become increasingly pronounced, requiring new approaches to market analysis based on geospatial methods. This study investigates the impact of wartime security risks on housing prices in Kharkiv during 2021–2025. The research is based on a dataset of 83 one-room apartments collected from the secondary housing market. Geographic Information Systems were applied to spatially classify residential properties according to their distance from areas exposed to military threats. Statistical analysis and cartographic visualization were used to identify temporal and spatial changes in housing prices and to assess the influence of military risk on market value. The results indicate that proximity to the frontline became one of the dominant factors affecting residential property prices after 2022. The greatest decline in housing values was observed in areas with the highest security risks, whereas districts located further away from the combat zones demonstrated greater market stability and a faster recovery. The findings confirm a clear relationship between housing prices and the spatial distribution of military threats. The proposed approach demonstrates the effectiveness of integrating geospatial analysis with statistical methods for monitoring wartime real estate markets and may support property valuation, urban planning, and post-war recovery strategies.

Keywords: Residential real estate; Housing prices; Spatial analysis; Military risk; Geographic Information Systems.

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Introduction

The Russian full-scale invasion of Ukraine in February 2022 had a significant effect on the functioning of the residential real estate market. Frontline cities became particularly vulnerable to security risks, infrastructure destruction, and population displacement (World Bank, 2023). Kharkiv has been suffering severe damage, with incessant destruction of civilian infrastructure, including residential buildings, schools, hospitals, and commercial facilities (Tomchenko et al., 2023).

Before 2022, housing prices were mainly determined by traditional factors such as accessibility, infrastructure, building quality, and urban location. Under wartime conditions, security-related factors became increasingly important, resulting in substantial spatial differentiation of housing values (UN-Habitat, 2023; RICS, 2024). A study by Trofymenko et al. (2024) revealed a significant role of the distance of land plots for servicing residential buildings and outbuildings from localized combat zones.

Purpose of the work: to assess the influence of wartime security risks on residential real estate prices in Kharkiv using GIS-based spatial analysis and statistical methods, and to determine the relationship between housing values and spatial location during 2021–2025.

Method and Theory

The study is based on a dataset of 83 one-room apartments located within seven administrative districts of Kharkiv: Kyivskiy, Saltivskiy, Shevchenkivskiy, Osnovyanskiy, Kholodnohirskiy, Industrialnyi, and Nemyshlianskiy. The database includes apartment size, condition, location, total price, and price per square metre. One-room apartments were selected to ensure methodological consistency and minimize the influence of differences in housing size and functionality.

Spatial analysis was performed using GIS technologies, which are widely applied in real estate studies to analyze spatially distributed data (Longley et al., 2015; Malysheva & Tretiak, 2021). Based on the distribution of wartime risks, infrastructure conditions, and territorial characteristics, the city was divided into three spatial zones representing different levels of security risk (Fig. 1).

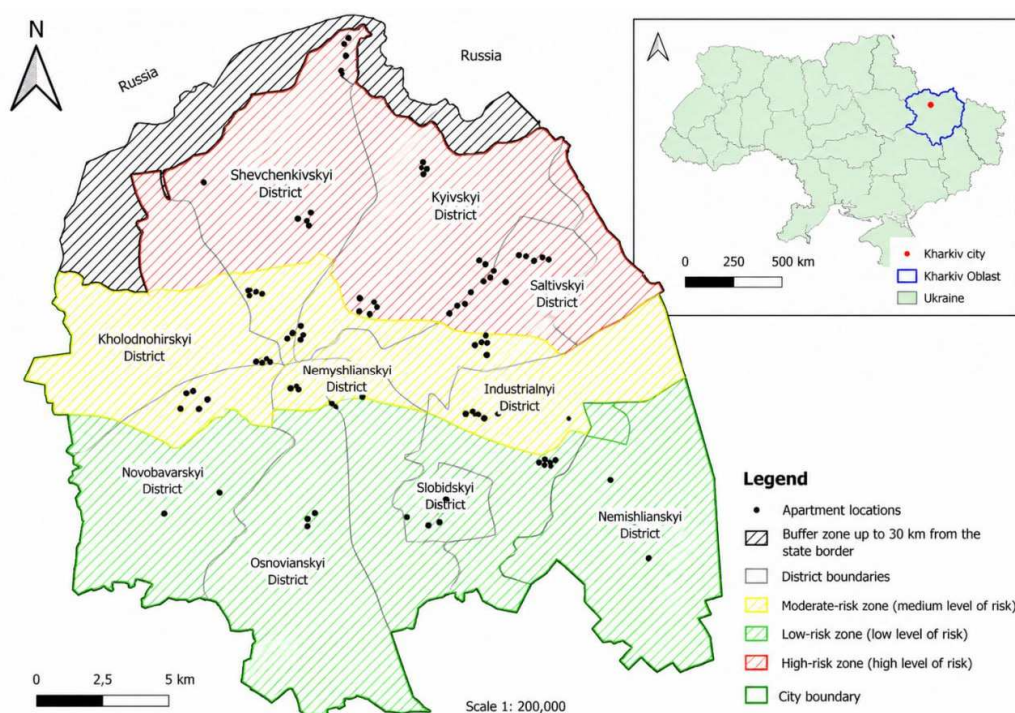


Figure 1. Spatial zoning of Kharkiv according to wartime security risks

The immediate risk zone includes the northern and northeastern territories (including the Saltivskiy district and parts of the Kyivskiy and Shevchenkiivskiy districts), which are characterized by the highest level of destruction and security risks. The central zone encompasses the historic city center with a high concentration of business and infrastructure activity, while the outer zone includes the southern and western areas with a relatively lower level of risk.

To evaluate the relationship between housing prices and spatial location, Pearson correlation analysis was applied (Wooldridge, 2016). Additional normalization procedures were performed to reduce the influence of apartment condition and district-specific characteristics, allowing the spatial factor to be assessed more accurately.

Results

At the first stage, we examined the dynamics of the average price for residential real estate in Kharkiv for 2021–2025. As can be seen from Fig. 2, in 2021 the average price was \$835.07/m², followed by a sharp decline to \$530.21/m² in 2022, reflecting the shock impact of the onset of full-scale armed aggression and destabilization of the real estate market.

In 2023–2025, a gradual recovery of the price level is observed: \$624.78/m² in 2023, \$698.97/m² in 2024, and \$761.31/m² in 2025. The overall trend indicates a partial adaptation of the market to the new operating conditions; however, as of 2025, the pre-crisis level of 2021 has not been fully restored.

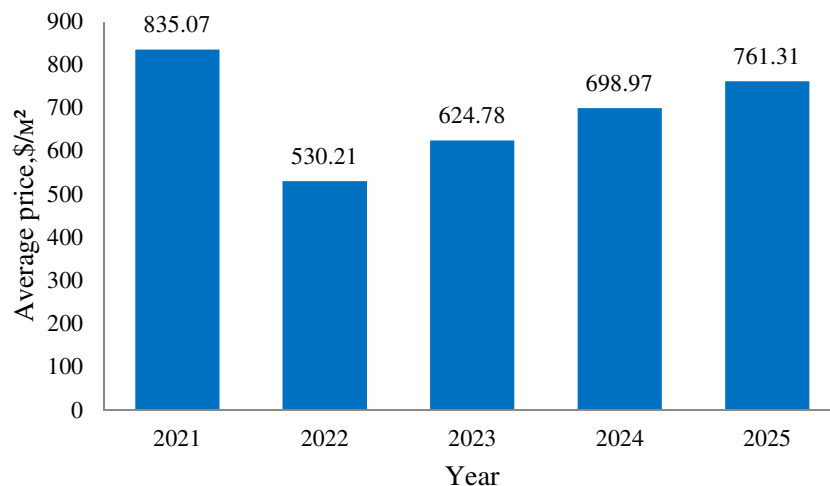


Figure 2. Dynamics of the average price of residential real estate in Kharkiv, 2021–2025, \$/m²

In the second stage of the study, average housing prices were calculated by spatial zones in Kharkiv (Table 1). Analysis of the results indicates a significant transformation of the structure of the residential real estate market. In 2021, a classic price hierarchy was observed, with the highest prices in the central zone (\$1,019/m²) and the lowest in the adjacent zone (\$705/m²), while remote districts occupied an intermediate position.

In 2022, a sharp structural breakdown of the market occurred, which was manifested in a significant drop in prices in the adjacent zone and a much smaller decrease in the remote one. This led to a reorientation of demand to safer areas and an increase in the role of the risk premium in the pricing structure.

In 2023–2024, a gradual recovery of the market is observed with pronounced spatial asymmetry: remote areas demonstrate faster recovery rates compared to the adjacent, high-risk, zones, which indicates the consolidation of the new demand structure.

In 2025, a new market configuration is taking shape: the remote zone (\$888/m²) is nearly on par with the central zone (\$915/m²), while the high-risk adjacent zone remains significantly cheaper (\$480/m²). The difference between the remote and adjacent zones is \$408/m².

Table 1. Average housing prices by spatial zones in Kharkiv during 2021–2025 (USD/m²)

<i>Year</i>	<i>High-risk zone</i>	<i>Central zone</i>	<i>Remote zone</i>
2021	705	1,019	781
2022	294	667	631
2023	373	796	705
2024	434	863	800
2025	480	915	888

The pie chart (Fig. 3) reflects the structure of average prices for residential real estate by spatial zones in 2021–2025 in relative terms. The central zone has the largest share — 41.2%, which indicates its dominant role in the formation of the average price level and is due to the high concentration of infrastructure and demand.

The remote zone accounts for 36.8%, demonstrating a significant market share and a relatively stable cost level in conditions of reduced security risks. The high-risk adjacent zone exhibits the smallest share of 22.1%, which reflects a significant impact of military risks and destruction on the decline in housing prices.

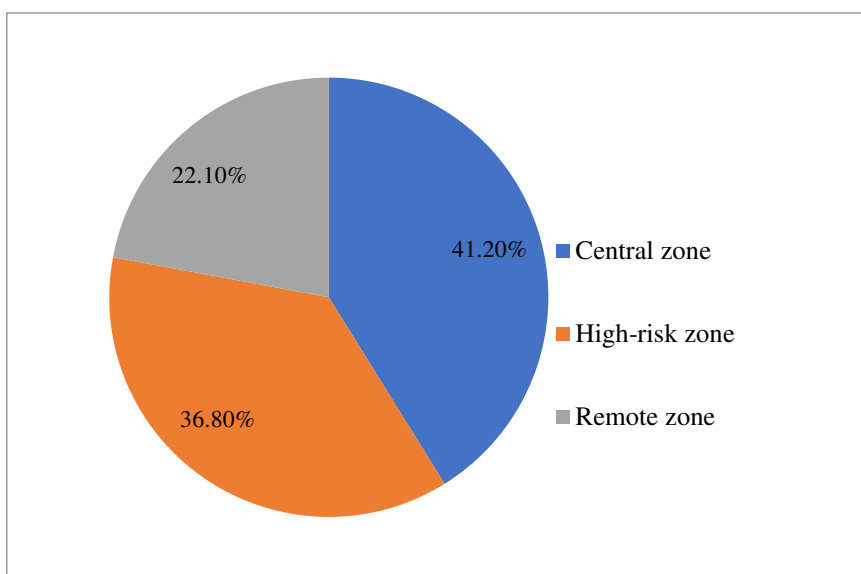


Figure 3. Structure of average prices for residential real estate by spatial zones in 2021–2025, %

To assess the strength of the spatial relationship, Pearson correlation coefficients were calculated for each year of the study period. After normalization, the correlation coefficient increased from 0.505 in 2021 to 0.778 in 2025. The coefficient of determination reached 0.606, indicating that more than 60% of the variation in housing prices can be explained by spatial location after controlling for apartment characteristics.

The strongest relationship was observed in 2025. The corresponding correlation box demonstrates a clear positive relationship between housing prices and distance from high-risk areas. Statistical testing demonstrated that the relationship found is significant and cannot be explained by random variation.

Overall, the results indicate that war risks have caused a radical transformation in the traditional determinants of housing prices. Spatial characteristics related to security have become more influential than the conventional advantages of urban location.

Conclusions

The housing market of Kharkiv experienced substantial transformations during 2021–2025 due to wartime conditions. GIS-based zoning revealed significant differences in housing price dynamics between areas with different levels of security risk.

The greatest decline in housing prices occurred in high-risk districts, whereas remote areas demonstrated greater resilience and faster recovery. By 2025, a pronounced spatial differentiation of housing values had formed across the city.

Correlation analysis confirmed a statistically significant relationship between housing prices and spatial location ($r = 0.778$; $R^2 = 0.606$), indicating that security-related factors have become major determinants of housing market behavior under wartime conditions.

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