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Research Article /Review Article:

A Spatial Analysis of Real Estate Transaction Intensity from 2020 to 2024: The Case of Isparta Central District

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Abstract

The spatial distribution of real estate transactions provides important insights into urbanization dynamics, economic development, and land-use trends. In this study, the temporal and spatial changes in real estate transactions in Isparta Central District were evaluated using a Geographic Information Systems (GIS)-based approach, based on real estate transaction intensity maps for the years 2020–2024 obtained from the Parcel Inquiry Application of the General Directorate of Land Registry and Cadastre (TKGM). Annual intensity and cluster maps were compared to analyze the spatial distribution of transactions, the areas of concentration, and changes in spatial patterns over time. The study period encompasses a process characterized by the COVID-19 pandemic, changes in living and housing preferences following the pandemic, significant increases in real estate prices, changes in housing loan interest rates and access to financing, and shifts in investment behavior. In addition, the potential effects of increased student dormitory capacity in Isparta on the demand for apartment-type housing were also considered. The findings indicate that real estate transaction intensity was predominantly concentrated in the city center and developing residential areas, while significant changes occurred in the intensity levels and spatial distribution of transactions over the years. In particular, the rapid increase in real estate prices, rising housing loan interest rates, restricted access to financing, and changes in investment preferences are considered to be associated with fluctuations in transaction volumes. Changes in housing preferences following the pandemic and local dynamics, such as the expansion of student dormitories, may also have played a role in shaping spatial patterns in the real estate market. Overall, this study reveals the spatial and temporal changes in the real estate market of Isparta Central District during the 2020–2024 period through intensity and cluster maps derived from official land registry data, and demonstrates that the findings may contribute to urban planning, land management, real estate market monitoring, and local decision-support processes.

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Contribution to the field statement:

This study provides a spatial and temporal assessment of real estate transaction patterns in Isparta Central District from 2020 to 2024 using official land registry intensity and cluster maps. By comparing annual patterns, it identifies persistent transaction concentrations and changing activity in developing residential areas, demonstrating the value of spatial data for market monitoring, urban planning, and land management.

Highlights:

- Official land registry maps reveal transaction patterns from 2020 to 2024.
- Transaction activity remained concentrated in central urban areas.
- Transaction volumes peaked in 2022 before declining through 2024.
- Developing areas to the north and northeast retained notable activity.

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1. Introduction

The real estate market is a sector that is directly associated with investment, employment, urbanization, and economic growth and constitutes an important component of the economic structure [1]. Transactions involving residential properties, land, agricultural land, and commercial real estate represent not only changes in ownership but also provide important indicators of population movements, investment preferences, urban development, and economic conditions. Therefore, the regular monitoring and evaluation of changes in the real estate market are important for urban planning, land management, the real estate sector, and investment decisions, particularly for public institutions and local governments [2].

In Türkiye, the registration and management of real estate ownership are carried out by the General Directorate of Land Registry and Cadastre [3]. The land registry is an official record system that safeguards the legal status and ownership rights of real estate and plays a fundamental role in protecting property rights. In recent years, through digital transformation initiatives, land registry and cadastral services have largely been transferred to electronic platforms, facilitating access to information and services related to real estate through digital platforms such as the Land Registry and Cadastre Information System (TAKBİS), Web Land Registry, and the Parcel Inquiry Application. This digital transformation has not only improved the efficiency of public services but has also created new research opportunities for the spatial analysis of the real estate market [4,5].

Official data on real estate provide an important source of information for assessing the current state of the real estate market, monitoring investment trends, evaluating urban development areas, and identifying changes in land use. In particular, examining the spatial distribution of real estate transactions over specific periods makes it possible to determine the areas in which real estate market activity is concentrated within a city, identify the directions in which new development areas emerge, and assess how investment patterns change over time. Therefore, integrating land registry data with spatial analyses can provide significant contributions to urban planning, land management, real estate valuation, urban development, and decision-support processes of local governments [6].

Geographic Information Systems (GIS) are among the important technologies that enable the storage, querying, analysis, and visualization of spatial data [7]. GIS-based analyses make it possible to compare the spatial distributions of real estate transactions occurring in different periods, identify areas of concentration, and monitor changes in these areas over time. In particular, heat maps and cluster maps enable the spatial patterns of real estate transactions to be visually represented and the tendency of transactions to concentrate in specific areas to be evaluated. In this respect, GIS enables the real estate market to be assessed not only in terms of the total number of transactions but also in terms of where and during which periods transaction activity is concentrated [8,9].

The spatial and temporal changes in the real estate market cannot be explained by a single factor and require the combined consideration of various economic, demographic, social, and urban developments [10]. In particular, housing loan interest rates, access to financing, and changes in real estate prices are among the key economic factors that may influence the decisions of individuals and investors regarding real estate acquisition. Rising borrowing costs and limited access to financing may restrict the participation of buyers who seek to acquire real estate through credit, while rapid increases in real estate prices may also affect purchasing power and transaction volumes. Conversely, during periods of increasing economic uncertainty, the use of real estate as an investment instrument may lead to changes in investment behavior and increased transaction intensity in certain areas [11].

The COVID-19 pandemic, which began in 2020, marked an important period that should be taken into consideration in understanding the development of the real estate market. In addition to movement restrictions, economic uncertainties, and changes in working arrangements during the pandemic, individuals' expectations regarding their living environments also changed. The widespread adoption of remote working and distance education led to housing being considered not only as a place of residence but also as a living environment for work and educational activities. In the post-pandemic period, changes in lifestyles and housing preferences have been considered among the factors that may have contributed to variations in housing demand and activity in the real estate market across different areas [12,13].

Following the pandemic, high inflation in Türkiye, rapid increases in real estate prices, changes in loan interest rates, and increasingly constrained access to financing have significantly altered the dynamics of the real estate market. The substantial increase in real estate prices may, on the one hand, have supported demand among individuals purchasing property for investment purposes, while, on the other hand, limiting the capacity to acquire housing due to high price levels and financing costs. This situation necessitates evaluating transaction volumes not only in terms of price changes but also by taking into account the differences between purchases made for investment purposes and those made for owner-occupation [14].

From the perspective of Isparta Central District, another factor that may influence the spatial structure of the real estate market is the student population and the associated changes in housing demand. In particular, increases in student dormitory capacity and the opening of new dormitories may be considered developments that can lead to changes in students' housing preferences. The expansion of dormitory facilities may reduce or reshape demand for student-oriented apartments and rental housing in certain areas. However, establishing such a relationship directly in terms of cause and effect requires the joint evaluation of additional data, including student population,



dormitory capacity, occupancy rates of apartment-type housing, and types of real estate transactions. In this study, this development is considered as one of the local dynamics that may be taken into account when interpreting the observed spatial patterns of real estate transactions.

Urban development and accessibility are also among the important factors to be considered when evaluating changes in the real estate market. The concentration of public institutions, commercial areas, educational and healthcare services, and transportation facilities in city centers may contribute to the concentration of real estate demand in specific areas. In addition, the development of new residential areas, land-use planning and development practices, urban growth directions, and changes in transportation infrastructure are spatial dynamics that may influence the expansion of real estate transactions toward areas surrounding the city center. Therefore, changes in transaction intensity over the years should be evaluated not only in relation to economic indicators but also in conjunction with the physical development processes of the city [15].

In this context, the period from 2020 to 2024 represents a significant period characterized by the concurrent occurrence of the COVID-19 pandemic, changes in living and housing preferences following the pandemic, high inflation, rapid increases in real estate prices, changes in housing loan interest rates and access to financing, shifts in investment behavior, and student housing dynamics specific to Isparta. How these developments were reflected in the spatial distribution of real estate transactions and which areas experienced changes in transaction intensity over time therefore constitute important issues for investigation.

Within this framework, the following research questions were addressed in the study:

- In which areas of Isparta Central District are real estate transactions concentrated?
- How has the spatial distribution of transaction intensity changed between 2020 and 2024?
- In which areas do significant clusters and hotspots of real estate transactions occur?
- What relationship exists between the economic changes experienced during and after the COVID-19 pandemic and the observed temporal and spatial changes in transaction intensity?
- What role do housing loan interest rates, access to financing, and rapid increases in real estate prices play in interpreting changes in transaction intensity?
- How do changes in living and housing preferences following the pandemic and shifts in investment behavior contribute to the interpretation of the spatial distribution of transaction intensity?
- How can the expansion of student dormitories and potential changes in demand for apartment-type housing be evaluated in terms of the spatial pattern of the real estate market in Isparta Central District?
- Can the observed changes in transaction intensity be associated with the urban growth directions and newly developing residential areas?

In line with these research questions, the main objective of this study is to reveal the temporal and spatial changes in real estate transactions in Isparta Central District by using the real estate transaction intensity and cluster maps for the years 2020–2024 obtained from the TKGM Parcel Inquiry Application. Within this scope, the maps for each year were comparatively evaluated to examine the areas in which real estate transactions were concentrated, how the areas of transaction intensity changed over time, and their potential relationships with the directions of urban development.

Another objective of the study is to identify the spatial clustering areas of real estate transactions and to evaluate how these areas change over the years. In this way, the study seeks to determine whether activity in the real estate market is concentrated primarily in the city center or whether it shows a spatial expansion toward newly developing areas. In addition, the spatial findings obtained were interpreted within the framework of factors such as the COVID-19 pandemic, economic conditions, increases in real estate prices, credit and financing conditions, changes in investment behavior, changing housing preferences, and changes in the student accommodation structure in Isparta.

It should be particularly emphasized that the effects of these economic and social variables on transaction intensity were not directly tested for causality in this study. These factors were considered contextual elements that may contribute to explaining the observed spatial patterns. Accordingly, the study interprets the changes observed in real estate transaction intensity in light of the economic, social, and urban developments during the relevant periods, without claiming to establish definitive cause-and-effect relationships.

This study aims to contribute to identifying the temporal and spatial dynamics of the real estate market in Isparta Central District by evaluating official land registry data within a Geographic Information Systems (GIS) environment. The findings are expected to provide spatial information that can support urban planning, land management, monitoring of the real estate market, the development of urban growth strategies, and decision-support processes of local governments. Furthermore, the study aims to provide an exemplary approach to the use of spatial data provided by official institutions for monitoring the real estate market and conducting academic research.



2. Material and Method

The study area comprises Isparta Central District. Isparta Central District was considered an appropriate study area for examining the spatial distribution of real estate transactions, as it encompasses urban residential areas, developing zones, and areas with diverse land-use characteristics. The study examines the spatial concentration patterns of real estate transactions conducted within the boundaries of the Central District on an annual basis.

The study utilized intensity and cluster maps of real estate transactions for the period 2020–2024. Accordingly, the study aimed to comparatively examine the changes in the spatial distribution of real estate transactions over the five-year period.

The primary data source used in the study is the “Analysis → Transaction Intensity” module available in the Parcel Inquiry Application of the General Directorate of Land Registry and Cadastre. Through this module, Intensity (Heat Map) and Cluster (Cluster Map) maps representing the spatial distribution of real estate transactions were obtained.

The analyses provided by the TKGM Parcel Inquiry Application enable the spatial distribution of real estate transactions within the study area to be visually evaluated. In this study, maps generated separately for each year were used, and changes between the years were comparatively evaluated.

In this context, the dataset consists of real estate transaction intensity and cluster maps for the years 2020, 2021, 2022, 2023, and 2024.

The data used in the study are limited to the existing analytical outputs provided by the TKGM Parcel Inquiry Application. The sale prices, types of real estate, characteristics of buyers and sellers, and individual transaction details were not separately analyzed within the scope of the study.

To evaluate the spatial distribution of real estate transactions, two different analytical outputs provided by the Transaction Intensity module of the TKGM Parcel Inquiry Application were utilized in this study: the Intensity Map (Heat Map) and the Cluster Map.

The intensity maps illustrate the spatial density of real estate transactions within the study area through color gradients. An increase in color intensity on the map indicates a higher spatial concentration of real estate transactions in the corresponding area. These maps were used to identify the areas where transactions were concentrated and to determine the spatial changes in transaction intensity over the years. The cluster maps, on the other hand, illustrate the clustering of real estate transactions in specific areas and indicate the number of transactions within these clusters. Using these maps, clusters formed by real estate transactions in specific areas were identified, and their distributions across the study years were comparatively evaluated.

By using both analytical outputs together, the spatial distribution of real estate transactions was evaluated in terms of both visual intensity and transaction clustering.

The intensity and cluster maps obtained for each year were examined separately, and the temporal changes throughout the 2020–2024 period were comparatively evaluated. First, the intensity map for each year was examined to identify the areas where real estate transactions were concentrated. Subsequently, the cluster map for the corresponding year was used to evaluate the distribution of transaction clusters within these areas. In the comparisons between years, the spatial distribution of transaction intensity in and around the city center, the locations of areas exhibiting high and low transaction intensity, the areas where transaction clusters were formed, the continuity or changes in these clusters over the years, and whether the areas of high transaction intensity expanded toward newly developed residential and urban growth areas were taken into consideration.

Through this approach, the study sought to reveal not only the spatial distribution of real estate transactions in a specific year but also the spatial changes in transaction patterns over time.

As shown in Figure 1, real estate transactions in 2020 were predominantly concentrated in the Isparta city center. The cluster map indicates that transaction counts were relatively high in the city center and its immediate surroundings, while they decreased markedly toward rural areas. This pattern suggests that real estate transaction activity was concentrated in central areas characterized by greater accessibility and higher concentrations of commercial activities and public services.

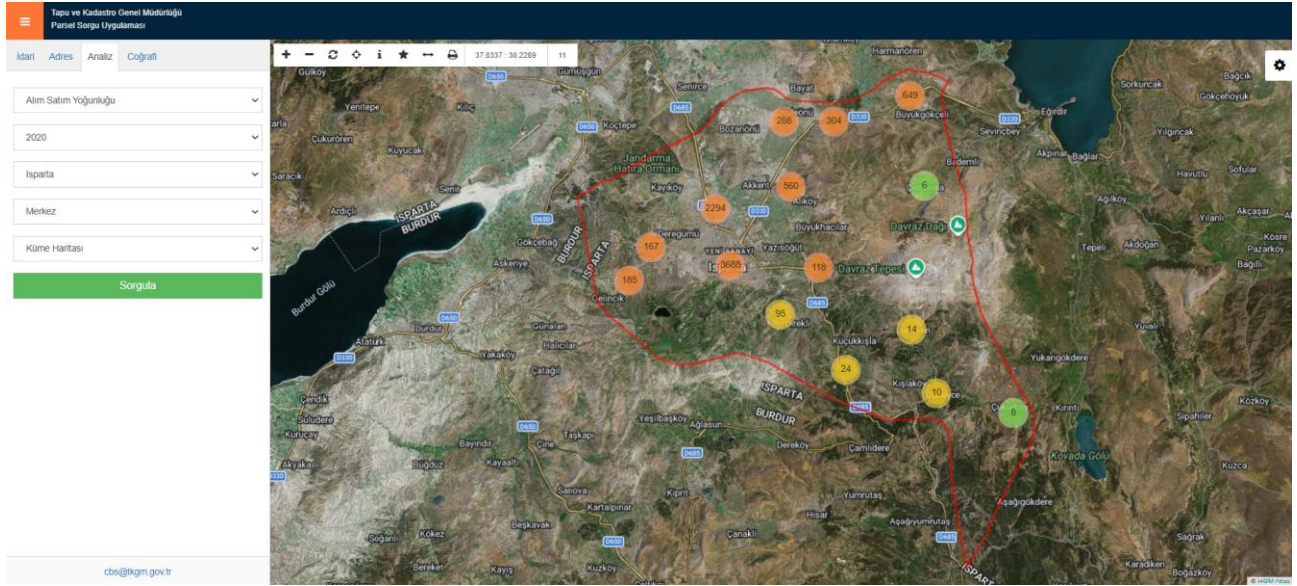


Figure 1. Cluster Map of Real Estate Transactions in 2020 Derived from the TKGM Parcel Inquiry Application

As shown in Figure 2, the 2020 real estate transaction intensity map indicates that transaction activity was highest in the city center, with a moderate level of intensity in the areas surrounding the center. In contrast, transaction intensity decreased markedly in rural areas. This spatial distribution indicates that real estate market activity was concentrated in central areas characterized by higher levels of accessibility, commercial activity, and residential development.

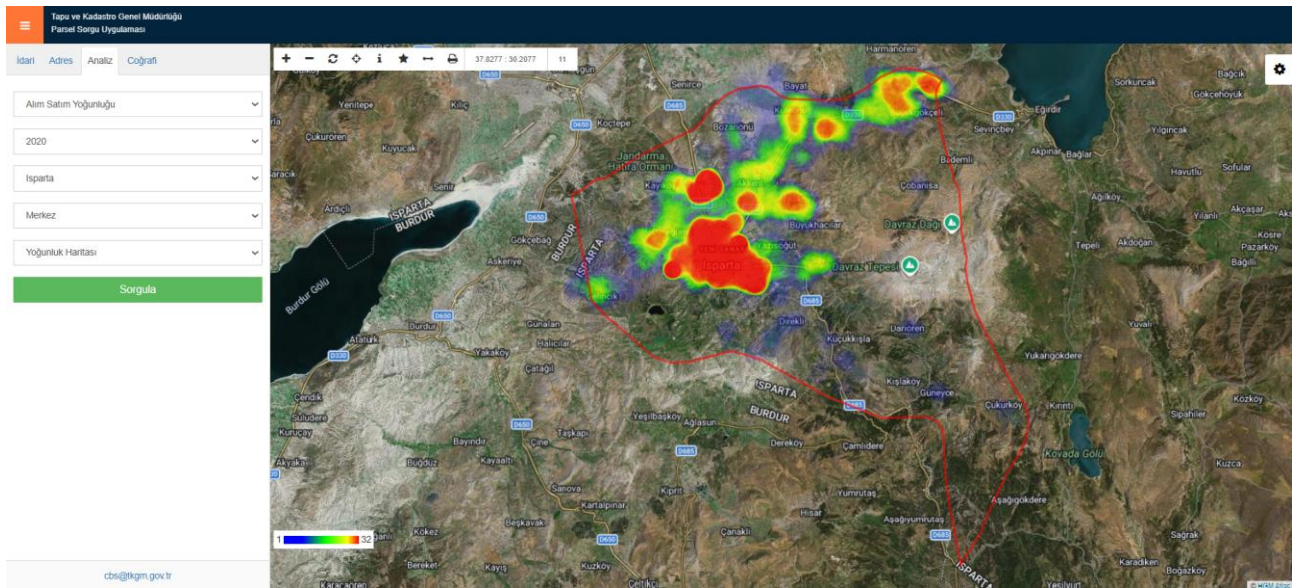


Figure 2. Intensity Map of Real Estate Transactions in 2020 Derived from the TKGM Parcel Inquiry Application

As shown in Figure 3, the 2021 cluster map of real estate transactions indicates that transaction activity continued to be concentrated in the city center, as observed in 2020. The clusters with the highest numbers of transactions were located in the city center and its immediate surroundings, while moderate transaction intensity was observed in the northern areas and lower intensity in rural areas. This pattern indicates that the real estate market maintained its center-oriented structure in 2021, with a higher number of transactions occurring in areas characterized by greater residential and commercial activity.

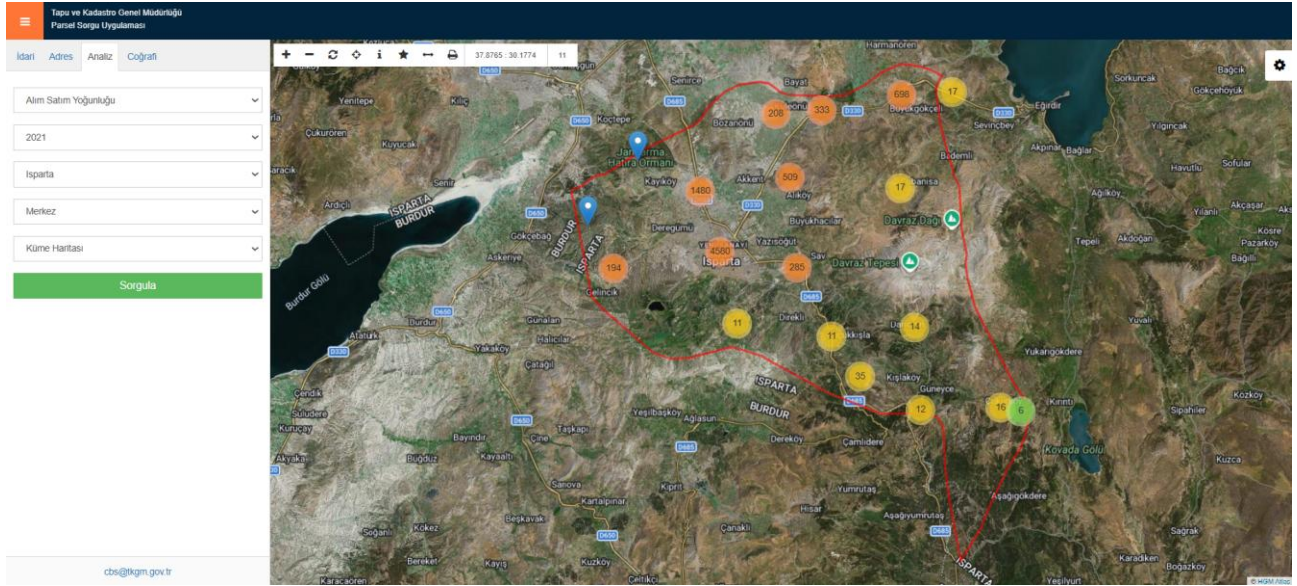


Figure 3. Cluster Map of Real Estate Transactions in 2021 Derived from the TKGM Parcel Inquiry Application

As shown in Figure 4, the 2021 real estate transaction intensity map indicates that the highest transaction intensity was concentrated in the city center and its immediate surroundings. In addition, high-intensity areas emerged in the residential areas to the north and northeast. Similar to 2020, transaction intensity remained low in rural areas, while the continuity of high-intensity areas around the city center indicates that the city center remained the primary focal point of the real estate market. This pattern suggests that real estate demand continued to be concentrated in areas characterized by residential development and greater accessibility.

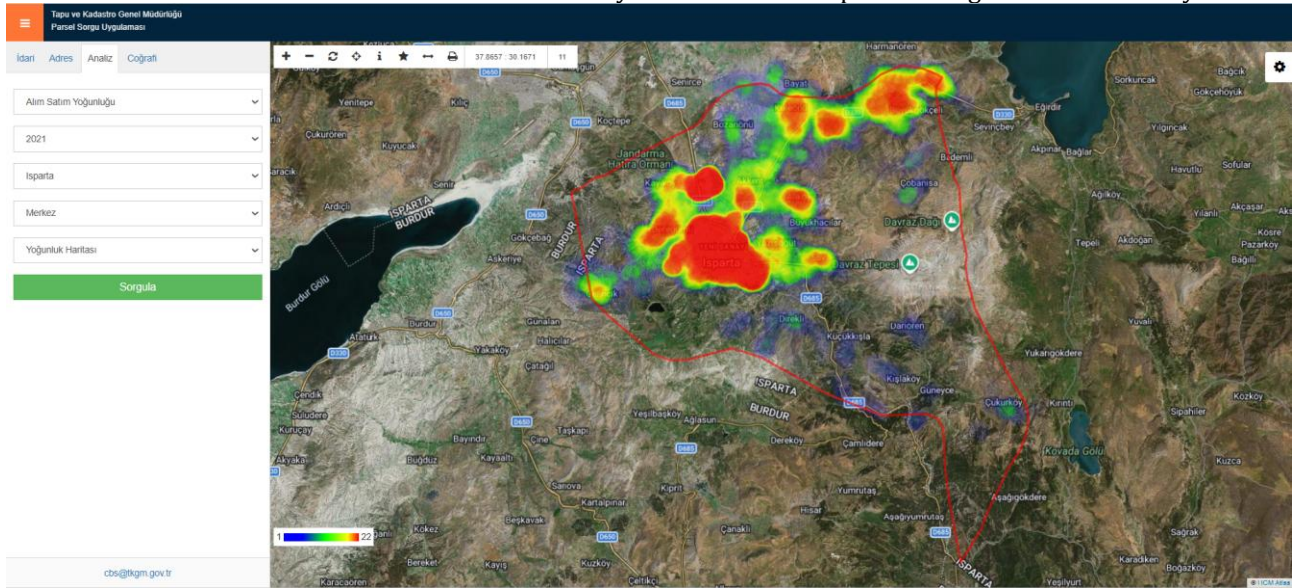


Figure 4. Intensity Map of Real Estate Transactions in 2021 Derived from the TKGM Parcel Inquiry Application

As shown in Figure 5, the 2022 cluster map of real estate transactions indicates that transaction activity remained concentrated in the city center, as in previous years; however, the size of the clusters and the number of transactions in the central area increased markedly. The formation of clusters with high transaction volumes particularly around the city center indicates that the increased activity in the real estate market in 2022 was spatially concentrated around the urban core. In addition, moderate transaction clusters observed in residential areas in the northern parts suggest that demand for real estate in areas of urban development continued. These findings are consistent with the spatial distribution of 2022, which had the highest transaction volume during the study period.

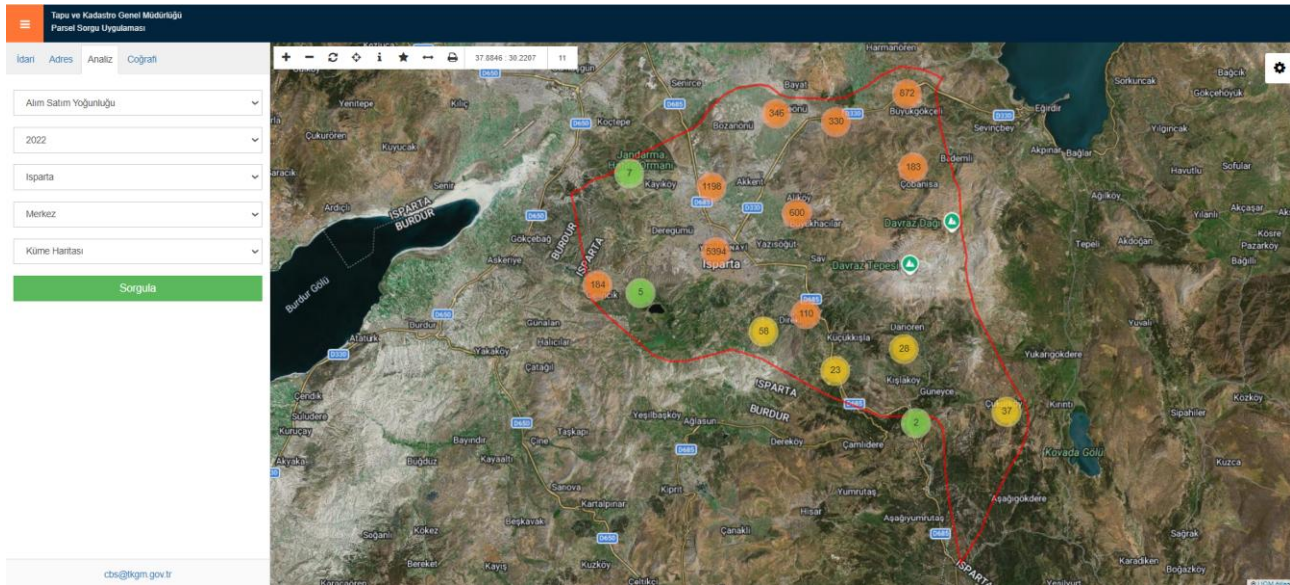


Figure 5. Cluster Map of Real Estate Transactions in 2022 Derived from the TKGM Parcel Inquiry Application

Figure 6 presents the property transaction density map for 2022. As observed from the map, the highest transaction density became more pronounced in the Isparta city center and expanded over a wider area compared with previous years. In addition to the urban core, the formation of high-density areas in the settlements located to the north and northeast of the city center is also noteworthy. In contrast, transaction density remained relatively low in the southern parts of the study area. This spatial distribution indicates that the substantial activity observed in the property market in 2022 was largely concentrated in the city center and developing settlement areas. This pattern is also consistent with the fact that 2022 recorded the highest number of property purchase and sale transactions during the study period.

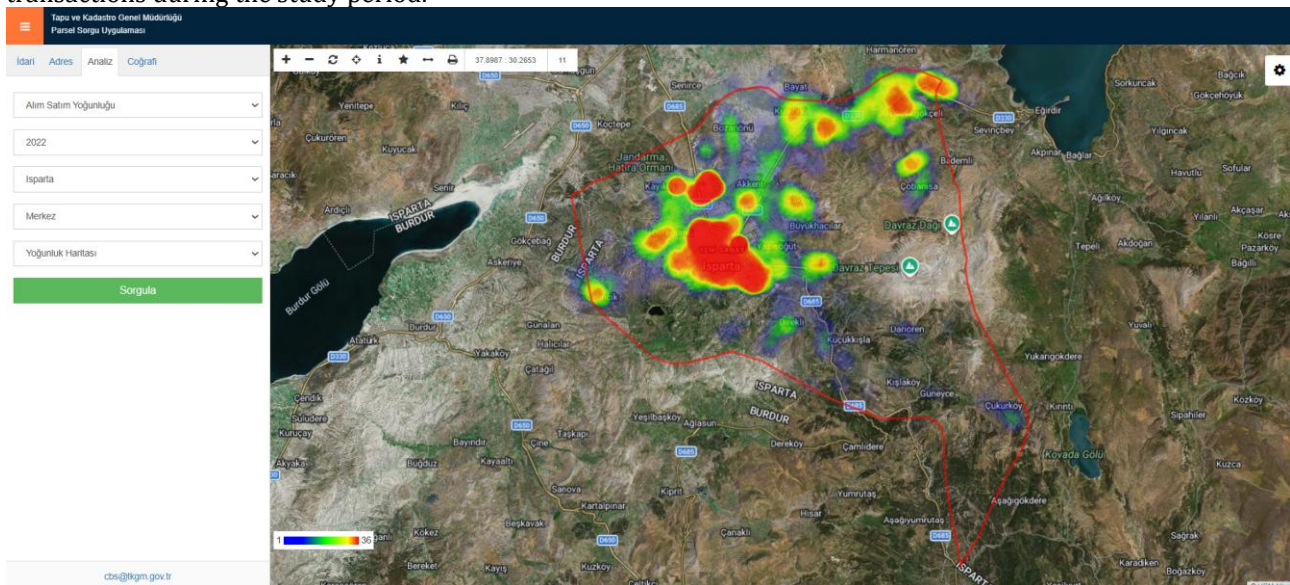


Figure 6. Property Transaction Density Map for 2022 Derived from the TKGM Parcel Inquiry Application

Figure 7 presents the property purchase and sale transaction cluster map for 2023. An examination of the map indicates that property transactions continued to be predominantly concentrated in the city center, consistent with the spatial pattern observed in previous years. However, compared with 2022, a partial decrease in both cluster size and transaction volume is evident in the central area. Medium-sized clusters persisted in the settlement areas located to the north and northeast, while transaction density remained relatively low in the southern parts of the study area. This spatial distribution suggests that, despite the decline in transaction volume in the property market in 2023, the center-oriented spatial pattern was maintained, while purchase and sale activities continued in areas undergoing urban development.

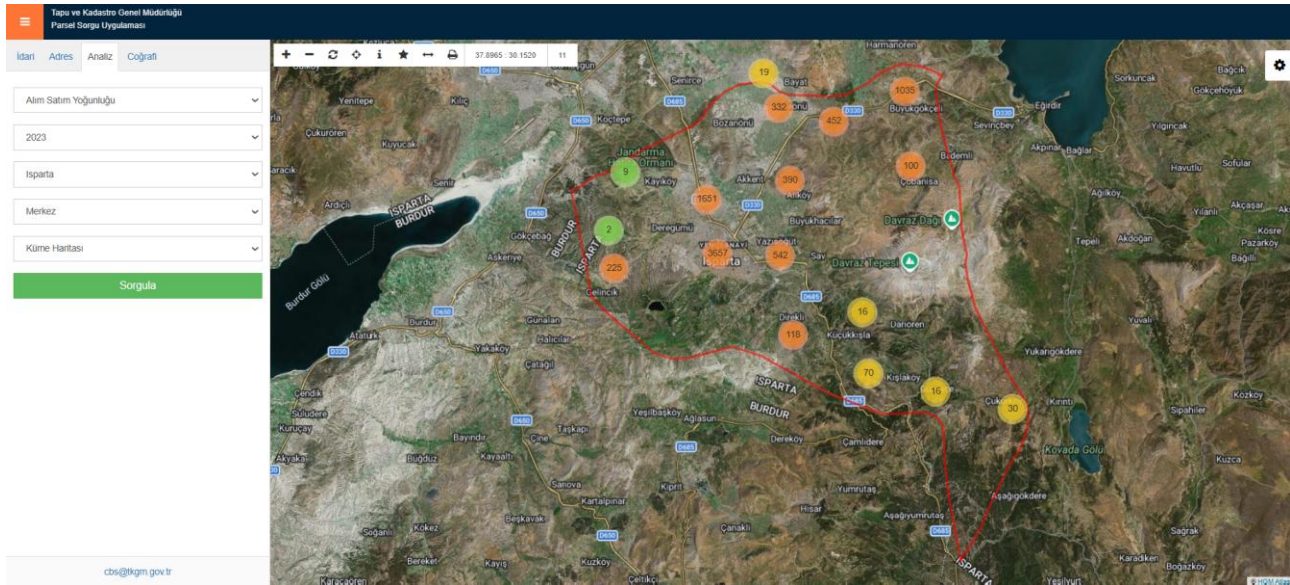


Figure 7. 2023 Property Transaction Cluster Map Derived from the TKGM Parcel Inquiry Application

Figure 8 presents the property purchase and sale transaction density map for 2023. An examination of the map reveals that the highest transaction density continued to be concentrated in and around the city center; however, compared with 2022, a partial contraction in the spatial extent of high-density areas can be observed. Nevertheless, high- and medium-density transaction areas remained prominent in the developing areas to the north and northeast of the city. In the southern parts of the study area, transaction density remained relatively low. This spatial pattern indicates that, despite the decline in the total number of property purchase and sale transactions in 2023, the spatial center of attraction of the property market remained unchanged, with transaction activity continuing to be predominantly concentrated in the city center and developing settlement areas.

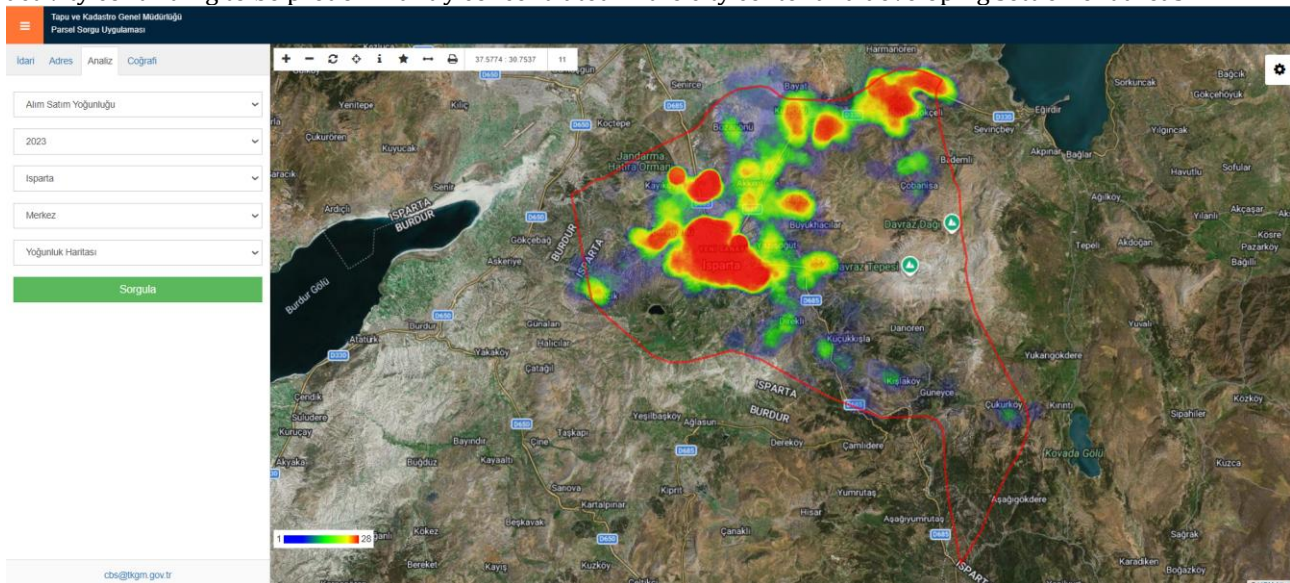


Figure 8. Property Transaction Density Map for 2023 Derived from the TKGM Parcel Inquiry Application

Figure 9 presents the property purchase and sale transaction cluster map for 2024. An examination of the map reveals that property transactions continued to be predominantly concentrated in the city center, as observed in previous years; however, the declining trend in both cluster size and transaction volume in the central area persisted. Medium-sized clusters remained present in the settlement areas located to the north and northeast of the city center, whereas transaction density remained limited in the southern parts of the study area. This spatial distribution indicates that, despite the decline in the total number of property purchase and sale transactions in 2024, transaction activity continued to be predominantly concentrated in the city center and areas undergoing continued urban development. Furthermore, the fact that the transaction clusters exhibited a smaller-scale and more dispersed spatial structure compared with previous years suggests that the slowdown in the property market was also reflected in its spatial distribution.

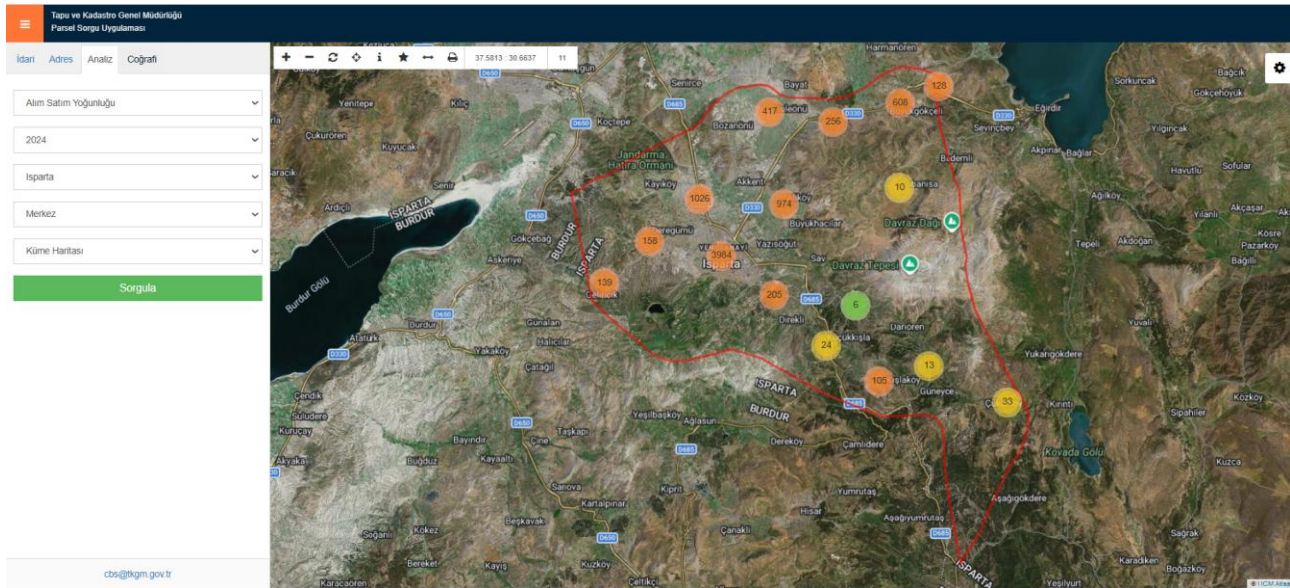


Figure 9. 2024 Property Transaction Cluster Map Derived from the TKGM Parcel Inquiry Application

Figure 10 presents the property purchase and sale transaction density map for 2024. An examination of the map reveals that the highest transaction density remained concentrated in and around Isparta city center, as observed in previous years. However, compared with 2023, although the spatial continuity of high-density areas was largely maintained, a declining trend in transaction density values can be observed in certain areas. Medium- and high-density transaction areas persisted along the development axes to the north and northeast, whereas transaction density remained relatively low in the southern parts of the study area. This spatial distribution indicates that, despite the decline in the total number of property purchase and sale transactions in 2024, the property market continued to be predominantly concentrated in the city center and developing settlement areas. Furthermore, the density map demonstrates that the contraction in the market did not fundamentally alter its spatial distribution, but rather resulted in a decrease in the intensity of transaction density.

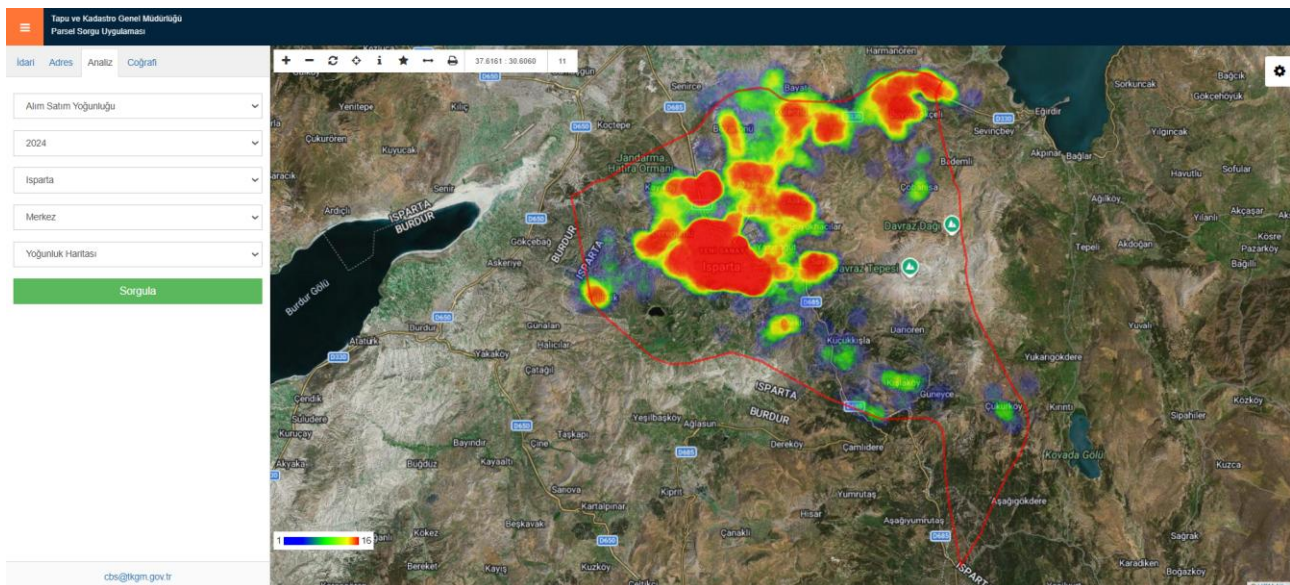


Figure 10. Property Transaction Density Map for 2024 Derived from the TKGM Parcel Inquiry Application

Table 1. Number of Property Purchase and Sale Transactions Conducted Between 2020 and 2024

Year	Total Number of Property Purchase and Sale Transactions
2020	8422
2021	8415
2022	9095



2023	8094
2024	7186

An examination of Table 1 reveals that the number of property purchase and sale transactions conducted in the central district of Isparta between 2020 and 2024 varied considerably across the years. The highest transaction volume during the study period was recorded in 2022, with a total of 9,095 transactions. This increase can be attributed to the acceleration of economic activity following the COVID-19 pandemic, the prevailing low real interest rate environment, and the growing preference for real estate as an investment instrument amid high inflation.

In 2020 and 2021, the total number of transactions was 8,422 and 8,415, respectively, indicating that the property market largely maintained its transaction volume despite the prevailing pandemic conditions. In particular, low-interest housing loans and the gradual normalization process contributed to the continuation of property sales during this period.

Following the peak recorded in 2022, the number of transactions declined to 8,094 in 2023 and further decreased to 7,186 in 2024. This decline can be attributed to several factors, including the rapid increase in housing prices, rising loan interest rates, limited access to financing, and prevailing economic uncertainties.

Overall, property purchase and sale transactions in the study area exhibited an increasing trend during the 2020–2022 period, followed by a steady decline beginning in 2023. This trend reflects the effects of monetary policies, changes in credit conditions, and broader macroeconomic developments in Türkiye on the property market in recent years. The findings demonstrate that the property market is sensitive to economic conditions and that spatial patterns of transaction density are directly influenced by economic fluctuations.

3. Discussion

The spatial distribution of property purchase and sale transactions in the central district of Isparta between 2020 and 2024 was evaluated using the density and cluster maps provided by the TKGM Parcel Inquiry Application. The findings reveal that property purchase and sale transactions were not homogeneously distributed across the study area, with distinct spatial concentrations particularly evident in the city center and developing settlement areas. Comparisons across the years further demonstrate that, although the primary spatial centers of transaction activity remained relatively stable, substantial variations occurred in terms of transaction density and spatial extent.

The persistent concentration of transactions in the city center suggests that the property market forms distinct spatial attraction areas in response to factors such as access to urban services, commercial activities, transportation opportunities, and population density. However, the increase in transaction density in developing areas surrounding the city center during certain years indicates that activity in the property market is not confined solely to the existing urban core but may also expand toward peripheral areas in accordance with prevailing directions of urban growth. This finding demonstrates that property purchase and sale transaction densities can be considered an important spatial indicator of urban expansion and the development of settlement areas.

Döner and Şirin (2018) emphasized that the Parcel Inquiry System developed by the General Directorate of Land Registry and Cadastre provides cadastral data to users in a spatially accessible format and constitutes an important infrastructure for the development of such data through GIS-based applications. However, their study also noted that the cadastral data provided through the Parcel Inquiry System were largely limited to two-dimensional parcel representations and that more advanced spatial data models were needed [16].

Mete and Yomralıoğlu (2021) utilized the spatial analysis capabilities of GIS to determine property values and developed a nominal property value map for Istanbul by jointly evaluating various factors affecting property values, including location, accessibility, education, healthcare, public services, and other environmental factors. The study demonstrated that spatial characteristics constitute a significant factor in determining property values and that GIS provides substantial advantages in the analysis, visualization, and dissemination of property-related data across large areas [17].

Alkan and Özfidan (2016) demonstrated that the accurate and objective determination of property values requires the integrated evaluation of spatial, economic, social, legal, and technical data related to properties. They further emphasized that Geographic Information Systems (GIS) provide significant capabilities for collecting, analyzing, and presenting such data to users. In addition, the study indicated that integrating property valuation systems with land registry and cadastral information systems, such as TAKBİS and MEGSİS, could contribute to conducting valuation processes more efficiently and reliably [18].

In evaluating the transaction density observed in 2020, the onset of the COVID-19 pandemic should be considered an important temporal factor. The changes in working and living patterns, economic uncertainties, and shifts in expectations regarding residential use that emerged during the pandemic were among the factors that may have influenced the demand structure of the property market. However, within the scope of the present study,



no direct causal relationship between the pandemic and transaction density was tested. Therefore, although the spatial pattern observed in 2020 may be associated with the conditions prevailing during the pandemic, this relationship cannot be interpreted as a definitive cause-and-effect relationship.

The pronounced transaction density observed in 2022 constitutes one of the significant findings of the study period. During this period, the increased concentration of high-density areas in and around the city center indicates a substantial level of activity in the property market. This period coincided with a phase in Türkiye characterized by high inflation and a rapid increase in property prices. The use of real estate as a means of preserving value against inflation and changes in investment behavior may be considered among the factors that could have contributed to the increase in transaction density. However, since the study does not include variables such as buyer profiles or transaction purposes, it cannot be asserted that the observed increase in transaction density was directly attributable to investment-oriented purchases.

In 2023 and 2024, transaction densities and clusters in certain areas were observed to have contracted compared with the previous period. This change can be evaluated in conjunction with economic factors such as the substantial increase in property prices, rising housing loan interest rates, and increasingly constrained access to financing. In particular, the increase in financing costs may have limited the purchasing decisions of buyers seeking to acquire property through credit. However, since the current dataset does not contain information on credit utilization or financing methods, it cannot be concluded that the observed spatial contraction was directly attributable to changes in credit conditions.

In evaluating the property market of the central district of Isparta, changes in the student population and housing structure should also be considered among the relevant local factors. In particular, increases in student dormitory capacity and the opening of new dormitories may have altered students' housing preferences, potentially reducing or reshaping demand for apartment-type housing in certain areas. This factor is particularly relevant for assessing the spatial structure of the property market in areas characterized by high student concentrations. However, a direct relationship between student dormitory capacity and property purchase and sale transactions was not tested in the present study. Therefore, this factor should be considered as a local dynamic that may contribute to explaining the observed spatial patterns.

Changes in lifestyles and housing preferences following the pandemic are also important for interpreting the spatial distribution of the property market. The widespread adoption of remote working and distance education practices may have altered patterns of housing use and housing preferences. However, determining the extent to which these changes affected transaction densities in the central district of Isparta requires additional data, including property type, dwelling size, intended use, and buyer characteristics.

Another significant finding of the study is that transaction densities did not shift entirely to different areas over the years but largely remained concentrated around the existing urban center. This indicates the presence of spatial continuity in the Isparta property market. Nevertheless, the emergence of transaction density in certain developing areas over time suggests that urban growth can be monitored in conjunction with activity in the property market. From this perspective, property purchase and sale transaction density maps can serve as a useful indicator not only for assessing market activity but also for evaluating patterns of urban development.

4. Results

The temporal and spatial variations in property purchase and sale transactions in the central district of Isparta between 2020 and 2024 were examined using density (Heat Map) and cluster (Cluster Map) maps obtained from the Purchase and Sale Density module of the TKGM Parcel Inquiry Application. In the study, the maps corresponding to each year were comparatively analyzed to determine the areas in which property transactions were concentrated, changes in transaction density over time, and the emergence of new clusters. The findings revealed that property purchase and sale transactions were not homogeneously distributed across the central district of Isparta, with distinct concentrations observed particularly in the city center, existing settlement areas, and urban development corridors. This pattern suggests that activity in the property market may be associated with spatial characteristics such as urban structure, accessibility, commercial activities, public services, and settlement density.

Comparisons across the years revealed that, although transaction densities remained persistent around certain spatial centers, both the intensity of transactions and the extent of their spatial distribution changed over time. A pronounced increase in transaction activity was observed in 2022, whereas in subsequent years, transaction densities decreased in certain areas or became concentrated within more limited spatial extents. When evaluated in the context of the economic and social developments that occurred during the study period, these changes suggest that factors such as the COVID-19 pandemic and subsequent changes in lifestyles and housing preferences, high inflation, rapid increases in property prices, rising housing loan interest rates, changes in access to financing, and shifts in investment behavior may have influenced activity in the property market. In particular, during inflationary periods, the perception of real estate as a means of preserving value and as an investment instrument may support demand, whereas rising property prices and increasing borrowing costs may have opposing effects



by constraining purchasing power and access to financing. Nevertheless, since these economic indicators were not directly analyzed in the present study, no definitive cause-and-effect relationship was established between these factors and the observed spatial changes.

Given Isparta's substantial student population, changes in student housing patterns constitute another local factor that should be considered in evaluating the property market. The expansion of student dormitories through new investments and the resulting increase in accommodation capacity may have reduced or altered students' demand for private housing, particularly apartment-type accommodation, in certain areas. This situation may have been reflected in the spatial distribution of the property market in areas with high concentrations of students. However, since no direct relationship was established in this study between student dormitory capacity, apartment occupancy rates, and property sales transactions, this factor was considered only as a potential local determinant. Similarly, changes in housing preferences and lifestyles following the pandemic may also have influenced locational preferences for properties.

Another important finding of the study is that the TKGM Parcel Inquiry Application constitutes a valuable data source for the spatial monitoring of the property market. By jointly evaluating density and cluster maps, it was possible to visually identify not only the areas characterized by high transaction activity but also the persistence and temporal changes of these areas over the years. In this respect, the study demonstrates that spatial data provided through the official land registry and cadastral infrastructure can be utilized through GIS-based analyses for urban planning, land management, and monitoring of the property market. In particular, the emergence of high transaction densities in developing areas suggests that these data can serve as a complementary indicator for assessing urban development trends.

Nevertheless, the study has several limitations. First, the research was limited to the central district of Isparta and the 2020–2024 period. In addition, the analyses were conducted based on the density and cluster maps provided by the TKGM Parcel Inquiry Application; variables such as property type, transaction value, property size, buyer and seller characteristics, transaction purpose, and financing method were not taken into consideration. Therefore, the study identifies the spatial and temporal concentration of property transactions but cannot directly explain the individual and economic factors underlying these concentrations. Furthermore, since the density and cluster maps used in the analysis are based on the existing analytical framework of the TKGM application, an independent hotspot analysis using alternative spatial statistical methods was beyond the scope of the study.

Future studies are recommended to evaluate property purchase and sale transactions together with property types and transaction prices and to conduct more detailed analyses at the neighborhood and, where possible, parcel levels. In addition, integrating population changes, migration patterns, student population, dormitory capacity, zoning plan amendments, new residential development areas, transportation investments, and socioeconomic indicators with land registry data would contribute to a more comprehensive explanation of the factors underlying changes in transaction density. Furthermore, the use of methods such as Moran's I, Getis-Ord G_i^* , Kernel Density Analysis, and spatial regression could enable a more detailed assessment of the spatial dependence of property transactions and the identification of statistically significant hot and cold spots. Comparative studies conducted across different cities and over longer time periods would also contribute to a more comprehensive understanding of the spatial and temporal dynamics of the property market in Türkiye.

It was determined that property purchase and sale transactions in the central district of Isparta were concentrated in specific spatial areas of attraction, although the intensity and distribution of these concentrations varied over time. In interpreting these changes, it is important to consider economic conditions together with urban development, housing preferences, investment behavior, and local housing dynamics. The evaluation of density and cluster maps obtained from the TKGM Parcel Inquiry Application within a GIS environment provides a practical and applicable approach for monitoring spatial activity in the property market. The findings are expected to contribute to urban development and land management decisions of local authorities, the efforts of public institutions to monitor the property market, and future spatial studies on property transactions.

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Conflicts of interest:

The authors declare no conflicts of interest.

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