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Unconditional authorization: Insights from the 2018 Development Amnesty in Türkiye

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Abstract
Unauthorized housing is a phenomenon exceeding the limits of income, location, and specific groups of households with varying motivations, from the housing needs of households to personal advantages such as extra income and housing wealth. Türkiye is among the countries experiencing enormous levels of unauthorized housing activities and authorization attempts. As recently observed, a development amnesty to manage these units via an uncontrolled, self-declared, and paid authorization process has received more than 10 million applications. However, the location and extent of these applications have yet to be declared, though they matter in both urban planning and housing markets. This study delves into the possible locations of unauthorized housing in Türkiye concerning main land-use cover characteristics. For this purpose, this study fields a question to reveal the driving factors of unauthorized housing and the spatial reflections of the relationships between land use and changes in them. In this study, more than 700 thousand phone calls to the support center of the Ministry of Environment, Urbanisation and Climate Change have been utilized during the years selected, and data concerning land-use cover in Türkiye were examined at the district level. Geographically weighted regression and multiscale geographically weighted regression models were applied to investigate the spatial heterogeneity of the (change in) land-use cover on unauthorization. The results reveal that some types of land-use cover are significant and showed variegated trends. Moreover, the accumulation of unauthorized housing has been revealed in some metropolitan cities, including earthquake-prone areas and natural protection zones.

Keywords
Amnesty, Land cover, Türkiye, Unauthorized housing.

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1. Introduction

The increasing size of the urban population has been commonly associated with informal ways of shelter and amenity access. The characteristics and lower profile of urban newcomers in the Global South have been blamed for many consequences in flat-footed housing markets (Martinez and Chiodelli, 2021). However, today unauthorized housing is a phenomenon exceeding the limits of income, location, implementation method, and specific groups of households. The reasons have become very diverse; unauthorization is no longer explained by just poverty and each has created a vicious cycle (van Gelder, 2013).

Due to the variety of experiences, consensus has yet to be reached on the wording and definition of illegal, informal, or unauthorized housing in urban studies. Nevertheless, the main feature comes from lack and violations of law via additions, alterations, and removals and, sometimes, correlates with a result of failed and replicated management and planning processes produced by governments (Roy, 2005). For example, Castells and Portes (1989) approach informality concerning any activity unregulated by the formal institutions of society in a legal and social environment where similar activities are regulated. Martinez and Chiodelli relate housing informality regarding the lack of requirements that "dwellings are built, traded or used in violation of some formal procedure or rule in force in specific place and time" (2021, p.2). In addition, urban informality is outlined as "an ethnocratic planning approach allowing the urban elites to represent urban government as equal, civil and democratic, while at the same time denying some urban residents basic rights and services in the locations into which they were forced" (Yiftachel & Yacobi, 2003, p.689).

Dere and Kuyucu (2022) identify illegal settlements through their counter-space formation potential for society; however, they indicate that these settlements occur on the fringes of the law. From the other perspective, the housing problem of states highly affects the definition of unauthorized from either illegal or informal perspectives. Illegality loses its meaning when a considerable share of the population lives in illegal units. Similarly, Alterman and Calor (2020) argue that planning law functions comparatively well in the Global North; therefore, the use of "informal" is not appropriate in that context; "illegal" is more suitable because of the delegitimization of planning law. In the present article, "unauthorized" housing is deliberately referred to, rather than "illegal" or "informal", because both terms essentially involve a lack of public authorization for the whole or some part of the built structure.

To cope with unauthorized housing, governments have employed various methods such as tolerance, eviction, and authorization through upgrading, self-help, or transformation projects to prevent the production of new units and solve the problems of the existing ones (Iban, 2020). As a result, amnesties have become wildcards, developing an authoritarian approach and simultaneously giving a reason for the perpetual production of unauthorized units. Türkiye has had trouble for decades with extensive violations of planning laws and implementation. Following this experience, 14 amnesty laws have been passed since 1948, which legitimized unauthorized housing units and allowed their occupants to be involved in the housing market for any transaction and easy access to services. They have partly focused on specific cities and neighborhoods for the authorization and transformation process. Coinciding with amnesties, studies on unauthorization in Türkiye have assumed small scales for their studies and investigated the process and consequences of already known authorized housing areas. This study identifies the small scale of previous studies as a research and empirical gap.

The recent development amnesty in Türkiye was announced in April 2018 with the addition of a temporary article to Development Law no. 3194, giving a legal identity to unlicensed or unauthorized buildings built before 2018 through registration. Based on the owner's declaration of unauthorized structure, the fines were determined according to the number of violations

reported. Approximately ten million applications have generated a revenue of 17 billion TL. However, the number of units approved, the provinces and districts in which they are located, whether the land is publicly or privately owned, whether the buildings comply with the building standards, and many other details remain unknown. This study aims to investigate the district-level distribution of unauthorized housing and main land-use changes for recent years in order to understand which types and changes are more associated with unauthorized housing. To overview this, it examines the location of more than 700 thousand calls received by the Ministry of Environment, Urbanization, and Climate Change on the subject of development amnesty during 2018 and 2019 as an indicator of amnesty. This study uses the district locations of incoming calls to estimate the unauthorized housing distribution, which is not shared with researchers and, therefore, not directly available. More clearly, these calls acknowledge that the house of the household requesting information about the amnesty peace is unauthorized and that they are calling the call center for this reason. As such, each call and the district in which it is located point to unauthorized housing. The main research topic of the study is to reveal the types of spatial changes/land use that cause/can be explained together with unauthorized housing. It is known that unauthorized housing in Türkiye does not only exist in city centers or areas with permanent settlements; on the contrary, natural areas, agricultural areas, and easy-to-access locations that have been destroyed in recent years also host unauthorized housing. The main contribution of this study is derived from the questioning of unauthorized housing at the district level and country-wide perspective.

The article is divided into seven sections. The next section introduces the motivations and expectations that led to unauthorized housing and how the process has moved beyond poverty. The subsequent section is dedicated to an overview of the legalization of unauthorized housing. The third section describes the unauthorized housing experience in Türkiye during the urbanization process and legal attempts. The section after that anatomizes the data and research methods adopted, while the fifth presents and analyzes the results. The final section contains the conclusions.

2. The background of unauthorized housing

The genesis of unauthorization involves a wide range of factors that explain the impulses, processes, and outcomes of housing. The most important of these are the lack of effective housing policies and population mobility (de Soto, 2000; Hall & Pfeiffer, 2000), overcautious planning regulations (local planning, building codes, and building permits) (Patton & Sophoulis 1983), and power relations (Chiodelli et al., 2021). Unauthorized housing is linked to problems with land and/or housing units. Unauthorized housing refers to any violation of development rights (extensions, divisions, and removals compared to the original plan), lack of all necessary permits, and authorizations related to land ownership. A housing unit is considered unauthorized if it is built on land, which is owned by someone else without the consent of the owner (regardless of whether the land is developable or not), the state (forests, shores, legally protected zones, etc.), and the household itself, but which is not suitable for development. The existence of one of these conditions results in the housing being unauthorized.

2.1. Overcautious policies or lack thereof

From the chronological perspective during the post-war periods, the limited budgets of states led them to choose between industry/development and housing/infrastructure investments. In this equation, selecting the former meant ignoring the latter for some developing countries. However, while the new population has been needed to meet the labor power required by this choice, agricultural mechanization simultaneously has enabled the migration of households living in rural areas to metropolitan cities. Like

other inter-country practices, Hall and Pfeiffer associate informality with an experience of developed world hyper-growth cities invaded by the developing world population (2000). This process can also be evaluated as a neglected responsibility of governments to meet the housing need of households in number and is also related to their income level, household size, affordability and preferred locations. As a solution in the USA, for example, Durst and Wegmann (2017) argue that unauthorized housing is allowed within the farm belt to ensure the presence of seasonal migrant workers in the urban economy. Unlike extreme situations, adding a new floor without permission, like building a layer on top of the existing structure, has been a frequently used method of unauthorization in Türkiye (Egercioğlu, 2016).

Even if the housing supply is sufficient in the place of arrival, the migrant population causes housing cost pressure; hence, unauthorized housing has been a solution in over-responsibilized cities to produce affordable housing stock (Peck et al., 2013). The increasing divergence between income and housing cost/mortgage payments has been curbed by owners and tenants finding individual solutions by renting out divided, restructured, and extended units. To illustrate, illegal micro-apartments, rooftop squatter dwellings, and basement suites have recently emerged in housing provision despite their structural instability and lack of ventilation, natural lighting, and fire safety (Yau & Ho, 2017). Accordingly, a study comparing the income level of rooftop households in Hong Kong has revealed a level of income for those living on rooftops lower than the median income of other households living in the same area (Tanasescu et al., 2010). This situation has been interpreted as indicating that households are obliged to live in these unauthorized units because they cannot afford another housing unit with their income level. From the owners' perspective, unauthorized units have been exploited as a shield against instability and hyperinflation in Southeast Europe enabling housing wealth through authorization (Tsenkova, 2012) and rental income to ease the mortgage payment burden in the Global North (Mendez & Quastel, 2016).

Poverty and unauthorization have coincided in many geographies (van Gelder, 2013). Poor households have attempted to create affordable yet unauthorized housing on land belonging to the state. Within that scope, Collins (1991) evaluates the legalization of squatters in Türkiye as an individually created state backroom social housing policy and argues how the amnesty law contributed to overcoming the shortage or lack of social housing production. Even if governments have not produced social housing units for their citizens, they have provided indirect welfare state opportunities (Eder, 2010) through free land, no taxes, and unconditional development rights.

Legal gaps or constraints have led to various paths for producing unauthorized housing. While an enormous number of requirements in building codes and bureaucratic measures limit the production of legal housing, Chiodelli and Moroni (2014) claim that weak public administration has speeded up uncontrolled development in many urban and rural areas. Weak public administration, local and national elections (Collins, 1991), and the transition from former socialist to democratic systems (Tsenkova, 2012) have paved the way for unauthorized housing developments due to the unclear duties and control areas of the authorities. Furthermore, the expectations of tolerance (Chiodelli et al., 2021), promises from governments for authorization, and voting potentials (Erman, 2001) have not only increased unauthorized housing activities but also decreased construction permits during election periods (Türel, 1992).

The arbitrary implementation of unauthorized housing units has spread to even forests and water basins. For example, elite informality is apparent in protected forest areas in Colombia, representing a concealing cluster with very high-quality housing units (Martinez & Chiodelli, 2021). As violations are encouraged, access to these enclaves has been restricted through gates and security controls. Similarly, López-Casado (2020) states that in Spain the proliferation unauthorized

second homes and constructions for weekend activities on the peripheries of existing cities have led to the destruction of natural areas having agricultural capacity with the total area of illegal parcels being more than 1.5 times the size of the planned main cities.

2.2. The legalization of unauthorized housing

Although unauthorized housing has been examined in a considerable number of studies, the process of legalization has been neglected due to the variety and dynamics of legal frameworks. In many countries, legalization has started with an amnesty law indicating the scope, process, and actors. Applicants should indicate the starting/completion dates of their construction and other housing characteristics together with the unauthorized parts of their units. Then, the process defined how authorization starts for the qualifying applicants. It is worth indicating, as Alterman and Calor (2020) state, that the process has not worked the same for all citizens and unauthorized units in many parts of the world. Due to the courts' interventions, the enforcement process has been highly selective among households based on income.

Nevertheless, the authorization process can be evaluated based on self-declaration and an inspection-oriented approach. Well-calculated legalization fees, enough to at least reveal the dead capital, have also been frequently used to reduce the costs to the state (Potsiou, 2014). There have also been symbolic fees, such as 1 euro per m2, which can be seen as an essential step in making the legalization process affordable and inclusive (Potsiou, 2014). However, the same situation can be seen as encouraging and facilitating households to produce unauthorized housing.

The questioning of unauthorized units regarding building standards and zoning codes has been rarely applied in amnesties because of their forgiveness aspect. Basement suites, one of these examples, the rental units of low-income households, have been considered units that met the standards without requiring new infrastructure investment (Tanasescu, Wing-tak and Smart, 2010). As Varley examines in Mexico, where various conditions have been questioned after the application, the legalization has resulted in a de jure gain for some and a de facto loss for some (not applying, parcel occupation in an unacceptable location) (1987). Despite the main characteristic of the land, a protected forest area in Colombia and many luxury units have benefited from authorization processes (Martinez & Chiodelli, 2021).

The time allowed for the application and decision also varies based on the following steps. First, preparation of the necessary documents for authorization (sometimes making a plan if it is an unplanned area) and approval of the application or the plan through different authorities took so long that the application period ended before a decision could be received, even as long as 10 years in some cases. Moreover, there are examples of countries where the process is prolonged and only the applications are collected (Potsiou, 2014). However, the frequency, cover, and path followed during the authorization process have accelerated the pace of construction of unauthorized units and raised the expectation of unconditional legalization for these units wherever they are located. In addition, after the legalization process, the next episode in the unauthorized construction and extension process starts due to the expectation of legalization sooner or later.

2.3. The solution to what

Such authorization has impacted households and housing markets in many respects. For example, Varley (1987) argues that there is a close link between authorization and improvements in housing conditions for low-income households due to the increasing tenure security and decreasing risk of eviction. The power of organized crime institutions has diminished in at least some transactions carried out after authorization was granted for these housing units; for example, taxes have been paid to government agencies (Chiodelli, 2019). In the long run, the authorization of these units can be evaluated as the official bringing into

circulation of the housing market and financialization (Ark-Yildirim, 2020); however, along with this process, prices increase of the only units that the poor in the city can only afford and new development expectations or transformation pressures increase noticeably (van Gelder, 2013). Registration facilitates transactions such as sales and leasing because, as Aslan and Dinçer (2018) argue, the need for a construction permit or residency permit for mortgage applications prevents households from utilizing credit for unauthorized units. It happens as follows: the sale and buying of unauthorized units have not been banned, yet the agreement has stayed hidden between these two actors without legal protection for both sides. Therefore, the process becomes risky if either of them claims a discrepancy or denial.

3. The frame of unauthorization in Türkiye

The urbanization experience in each country and the political orientation of the ruling parties have led to the diversification of housing stock in Türkiye. According to Özdemir (2011), although city plans exist in Türkiye, the main factor determining spatial development has not been planning decisions but laws (including development amnesties), the changing economic structure of the country, and population movements. As experienced in many countries, high population mobility has been observed in Türkiye since the Second World War due to the increase in industrial investments and the decrease in policies supporting rural development. The legal stock that could not meet the increasing housing needs of the city's newcomers has been shaped by illegal means, in other words "gecekondu" in Turkish (Uzun, 2005). Hence, the unauthorized housing often described in Ankara (Uzun, 2005), Istanbul (Sadikoglu Asan and Ozsoy, 2018), Izmir (Bektaş Ata, 2020), and Bursa (Çalışkan & Akbulak, 2010) has been an urban element observed in all cities since 1950 where employment has been available. Various legal and institutional attempts have been made to address the spread and intensity of this problem (Özdemir Sarı & Aksoy Khurami, 2023).

The lack of policies promoting affordable and social housing units for low-income groups has also been associated with the justification of unauthorized housing units in Türkiye. Regular and multiple development amnesties have been blamed as a catalyst for unauthorized housing production (Keleş, 1978; Pamuk, 1996). The necessity has been raised of creating financial resources to solve the problem considering the high land prices and construction costs as the main reason leading to unauthorized housing, and of avoiding any more unauthorized housing (with Law no. 5218, 5228, 5431, 6188, 7367) (Özdemir, 2011). In this context, the first attempt was enacted in 1948 with a law numbered 5218 focusing only the capital city, Ankara. Ankara Municipality has been responsible for providing cheap land and material to the owners of unauthorized units that need to be rehabilitated and to households who are aiming to build new housing. In the following years, the Gecekondu Law No. 775, enacted in 1966, approached the causes of unauthorized housing beyond the urban land problem; hence, various duties were given to the municipalities for providing housing to those with low income. Some have been to provide infrastructure, carry out the planning and project process, and build social housing (Tekeli, 2012). A limited number of demolitions have taken place, yet the effect of non-actualized laws aiming to avoid new unauthorized settlements was overshadowed by political and economic factors, leading to an increase in ones in Türkiye (Erol, 2019).

Especially in the 1980s, the legalization of unauthorized housing through amnesties (Law no. 2805, 2981, 3290, 3366, and 3414) marked the beginning of an evolution of purpose from shelter to a means of wealth creation and enrichment (Uzun et al., 2010) and land invasions (Buğra, 1998). Legalized units are no longer affordable for low-income families because their value has increased due to the title deed; they have become part of the build–sell system and led to a windfall gain for the owners. The state's approach to unau-

thorized housing has changed in parallel to the shift from the developmental to the neoliberal era (Erman, 2016). Local and central governments have been affected by this change and trying to reap benefits from the process. Thus, with the law enacted in 1984 (2981), the scale of authorization reached high-rise apartments. This change has been followed by election campaigns in which infrastructure and services were promised to the old unauthorized areas (Dere & Kuyucu, 2022). The fact that until 1985 urban services had not been provided to those not having an occupancy permit undoubtedly made these services an essential part of urban policies. However, as Pamuk (1996) indicates, the requirement for this permit to access services such as electricity, water, and natural gas has been abolished. Households' ability to receive these services without units being authorized has been beneficial for service providers in the private or public sector as they can transact official bills. This change has also removed one of the biggest obstacles to the demand for unauthorized housing stock, resulting in expectations of future amnesties and other unauthorized housing units. These units initially due to need and then justified by all income groups over time, led to the creation of risky and authorized living spaces, as observed in the buildings destroyed during the earthquakes in 1999 in Marmara and Düzce, 2011 in Van, 2020 in Elazığ, and 2023 in Kahramanmaraş and many more provinces.

3.1. Unauthorized housing and amnesty after 2002

After a long period of tolerance, the Justice and Development Party declared unauthorized housing activities criminal in 2004. No more tolerance for unauthorized housing has been announced; rather than authorization being granted, the subsequent period witnessed government- and municipality-supported urban transformation and renewal projects until 2018. However, the trend towards illegal construction in Türkiye is not limited to the construction of entire houses without permission. Unauthorized additions such as basements, garages, warehouses, and attics were also made to increase the value of the property or to earn additional income by renting it out. Further, the arbitrary completion of projects left incomplete by construction companies, units built in areas that are not open to development or have protected status, and many more are the products of this prohibition.

After a long period of improvement in terms of authorization practices in Türkiye, the "development peace" enacted in April 2018 with a temporary amendment to Development Law no. 3194 aimed to give legal identity by registering unauthorized buildings built before 2018. The main differences between this and the previous amnesties are as follows:

- In previous amnesties, Ankara and Istanbul were dominant (Erensu, 2024), but in this one, almost every region in the country has benefited from it without distinction between rural and urban areas,
- Covering all kinds of non-authorized applications (from villas to houses, poultry houses, or containers) ("Yarısı kaçak rezidansa imar affı piyangosu", 2018),
- The first amnesty after a long period covering about 30 years of accumulated unauthorized units,
- Some of other amnesties led to change/activity in urban environments such as large-scale urban transformation or redevelopment projects (Uzun, 2006), but this one did not,
- A source of high income without providing infrastructure in a short period,
- The Ministry of Environment, Urbanization, and Climate Change was the body responsible rather than the municipalities (Polat, 2019).

Households who own unauthorized housing units have the right to legally register it in the official building registration system in return for their declarations and payment of the determined charge for the unauthorized part. Despite online applications, the government has opened a local bureau in neighborhoods known for unautho-

rized housing (Ark-Yildirim, 2020). The application period was extended because of the high demand; as a result, approximately eight million applications have been made, generating 25 billion TL in revenue (Gündoğmuş, 2020). According to the regulation, the information and revenues obtained will be used in urban transformation projects. However, it was not planned to transfer paid revenues to municipalities responsible for building registration system. However, it is unknown how many of the units' applications were approved, in which provinces and districts they were, whether the units were built on public or private land, which land use decisions were made, and whether the units comply with the development codes.

4. Data and method

In the current study, various datasets and methods were used. To establish a dataset for regression analysis, data from several sources were combined, processed, and layered. First, the multivariate regression analysis technique Ordinary Least Squares (OLS) was used to determine whether the areal size of land use patterns and their changes affect unauthorized housing formation. Using Moran's I, spatial autocorrelation was performed. The next step involved the application of two local spatial regression techniques. They are Multiscale Geographically Weighted Regression (MGWR) and Geographically Weighted Regression (GWR). Finally, the results of the models were interpreted and compared to determine the best-fitting one.

4.1. Data

Three datasets were employed: calls received by the responsible Ministry on the topic of the development amnesty (i) and Corine Land Cover for 2018 (ii) and Corine Land Cover for 2006 (iii). Data preparation was conducted using Geographic Information Systems (GIS) to obtain and visualize the geographical data. Due to the lack of accurate data on the extent of unauthorized housing buildings in Türkiye, received call data were obtained at the district level of Türkiye and transformed into a shape file to represent illegal buildings within the defined district boundaries. The calls in 2018 and 2019, when the authorization applications were received, were summed. The second dataset was overlaid with the official district boundaries, including the Land Cover of Türkiye in 2018, and the third one attributed to the Land Cover of Türkiye in 2006. As a result, the total area of land-uses in hectares was calculated at the district level for these two years. Unauthorized housing in Türkiye is not a phenomenon that can only be explained by relating it to the existing settled areas. In other words, it is possible to see unauthorized housing in a wide variety of land uses, such as in forest areas, agricultural areas, and even on the outskirts of ring roads because of the developing transportation network. For this reason, eleven main land use types and their subcategories as coded in Corine Land Cover were examined. However, categories such as dump sites, burnt areas and etc. were removed because they cover very few areas and are not represented in every district. In addition, other land use types were also evaluated, but only one of those with a high correlation was included in the model. From the calculated land use cover for districts, continuous urban fabric, discontinuous urban fabric, infrastructure (road and rail network and associated land, port areas, airports), agricultural areas, forest, and seminatural areas were exported after the multicollinearity of all variables was checked. The change in hectares from 2006 to 2018 was also recorded for each use of these lands. As a result, for 973 districts, the number of calls to the Ministry concerning the development amnesty and the total land use size in 2006 and 2018 and the difference between these years were obtained. The correlation between the potential independent variables was checked for multicollinearity. The defined and uncorrelated variables at the end of the process are represented with their descriptives in Table 1.

4.2. Method

The study focused on unauthorized housing in different districts by investigating the land use decisions and changes as factors to determine

Table 1. *Descriptive statistics of the variables.*

Variable at district level (unit)	Min	Max	Mean	SD
Received calls (#)	0	18265	739.5	1641.2
Continuous urban fabric in 2018 (ha) *(Cont_urb)*	0	2698.1	141.6	364.7
Discontinuous urban fabric in 2006 (ha) *(Disc_urb)*	0	7438.1	838	915.6
Change in discontinuous urban fabric from 2006 to 2018 (ha) *(Ch_disc_urb)*	-1899	3182	28.9	456.3
Infrastructure (road and rail network and associated land, port areas, airports) in 2018 (ha) *(Inf)*	0	1218	38	147
Agricultural, forest, and seminatural areas in 2018 (ha) *(Agr_for)*	0	401251	76695.6	63441

whichever are more influential on the local and global scale. OLS was the first analysis conducted to observe exploratory factors globally and it was followed by the spatial autocorrelation of residuals. In pursuit of a global scale, two spatial techniques (GWR and MGWR) were employed at the local level.

4.2.1. Ordinary Least Squares (OLS) and spatial autocorrelation

OLS was used to predict the continuous dependent variable (DV) (received calls in the present study) using one or more explanatory variables (EV) (Cont_urb, Disc_urb, Ch_disc_urb, Inf, Agr_for) and to determine the relationships between the variables. As follows:

Equation 1. Ordinary Least Squares

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \ldots \beta_k X_{ki} + \varepsilon_i$$

Here refers the i[th] value of the received calls, is the i[th] observation of the focused EV, is the error between the observed and what the model predicts, is the intercept, and is the coefficient of each EV. A higher with a statistically significant p-value indicates a stronger influence of the EV on the explanation of the DV. Following the OLS, to check whether spatial heterogeneity exists, a preferred method Moran's I is applied as shown in equation (Getis & Ord, 1992).

Equation 2. Moran's I Index

$$I = \frac{N \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} \sum_{i=1}^{n} (x_i - \bar{x})^2}$$

Here N is the number of values, and are the values in *i* and *j*, is the mean, and is the spatial weight matrix. While a positive Moran's I index indicates the tendency of spatial cluster spatially, negative value represents dispersion, and the p-value is an indicator of spatial dependency.

4.2.2. Spatial regressions

Geographically Weighted Regression (GWR) is a local form of linear regression to estimate the value at a given point based on its surroundings (nearest neighbors/distance), also checks the spatial non-stationary. GWR functions as follows:

Equation 3. Geographically Weighted Regression

$$Y_i = \beta_0(u_i, v_i) + \sum_{s=1}^{S} x_{i,s} \beta_s(u_i, v_i) + \varepsilon_i$$

Here is the value of the received calls as dv, is the intercept, is the [th] coefficient of EV, is the central coordinates of the feature, is the [th] EV, and is the error term. GWR tries to capture spatial differences and reveals relationships by adapting a multiple regression model that explores different relationships existing at different points in space (Brundson et al., 1998). For this purpose, GWR uses data from the neighboring locations and considers the distance from these neighbors to a referenced point (Sachdeva et al., 2022). However, as Şenyel Kürkçüoğlu (2023) indicated, GWR uses a single bandwidth for all parameters, while Multiscale Geographically Weighted

Regression (MGWR) works on varying bandwidths for variables instead of one. Thanks to this feature, the MGWR theoretically predicts DV better than GWR (Shabrina et al., 2021). MGWR is expressed as follows:

Equation 4. Multiscale Geographically Weighted Regression.

$$Y_i = \beta_0(u_i, v_i) + \sum_{j=0}^{m} \beta_{bwj}(u_i, v_i) x_{ij} + \varepsilon_i$$

Different from GWR, is the bandwidth used in the j^{th} location of the local regression coefficient.

5. Results

5.1. Model fit

To understand the performance of the model, (adjusted) R squared (R-sq) and the Akaike information criterion (AICc) are the frequently used model fit criteria. There R-sq referring to the variation explained by the model, AICc indicates the prediction errors. Therefore, the higher the R-sq, the lower value of AICc addresses a better fit of the model.

Based on the findings for the model fit as shown in Table 2, the model was improved by local regressions, with an explanation of 48% of the model through OLS, while it reached 73% with MGWR. In addition, the lowest AICc was obtained with MGWR. The diagnostics of GWR indicated an improved R-sq than obtained with OLS. However, among all the fitted models, MGWR had the highest R-sq (0.73) and lowest AICc.

5.2. Results of global regression

First, OLS was conducted with the five independent variables defined in Table 1. Spatial autocorrelation with Moran's I verified the spatial autocorrelation of residuals (I = 0.391, z-score=21.669 and p=0.000). The coefficient estimates are highly significant, with p-values less than 0.05. The VIF values of all independent variables revealed low multicollinearity (all values were less than the threshold of 7.5). As indicated in Table 3, Inf (infrastructure: road and rail network and associated land, port areas, airports) in 2018 and Agr_for (agricultural, forest, and seminatural areas in 2018) are negatively related to the number of calls received, so unauthorized housing units and other variables are positively related. The number of received calls decreases when the total area of infrastructure, agricultural, forest, and seminatural areas in 2018 increases. This shows that the existence of any infrastructure network partly avoids/limits unauthorized settlements together with agricultural, forest, and seminatural areas. In other words, the less infrastructure there is, the less control of governments over land. The total area of continuous urban fabric has the highest impact on unauthorized settlements, followed by the change in discontinuous urban fabric from 2006 to 2018 and the total size of the discontinuous urban fabric in 2006. The model shows that a 1-hectare rise in the area of the continuous urban fabric in 2018 increases the number of unauthorized settlements by 2.73 units. This means a higher share of unauthorized housing in the existing urban fabric.

Table 2. *Measures of goodness-of-fit for global and local regression models.*

Regression models	AICc	R-sq	Adj. R-sq
OLS	16526.4	0.48	0.48
GWR	17416.8	0.71	0.67
MGWR	16350.9	0.73	0.71

5.3. Results of local regressions

Based on the evidence, namely GWR and MGWR, were employed to represent the relationships. Figure 1 reveals the spatial heterogeneity in subnational fitting, reflected in the spatially varying local R-sq of both the GWR and MGWR models. The GWR and MGWR models fit better in the coastal areas of the Aegean and Mediterranean regions and Central Anatolia (Ankara and its surrounding). In contrast, the R-sq was consistently lower in the Northern and Eastern parts of the country. Local R-sq values were observed high in MGWR. MGWR computes that 553 districts (56.8% of districts) have a local R-sq of more than 0.7, and the local R-sq values less than 0.5 in 105 districts (10.7%). In GWR, the lower local R-sq values were revealed; 466 districts (47.8%) are

Table 3. *A summary of the statistics from OLS.*

Variable	Est.	Std. Err.	t-value	p-value	VIF
Intercept	485.63	63.01	7.70	0.000	-
Cont_urb	2.73	0.11	23.85	0.000	1.23
Disc_urb,	0.33	0.05	6.70	0.001	1.49
Ch_disc_urb	0.71	0.08	8.44	0.000	1.03
Inf	-0.84	0.27	-3.08	0.048	1.13
Agr_for	-0.00	0.00	-7.83	0.000	1.28

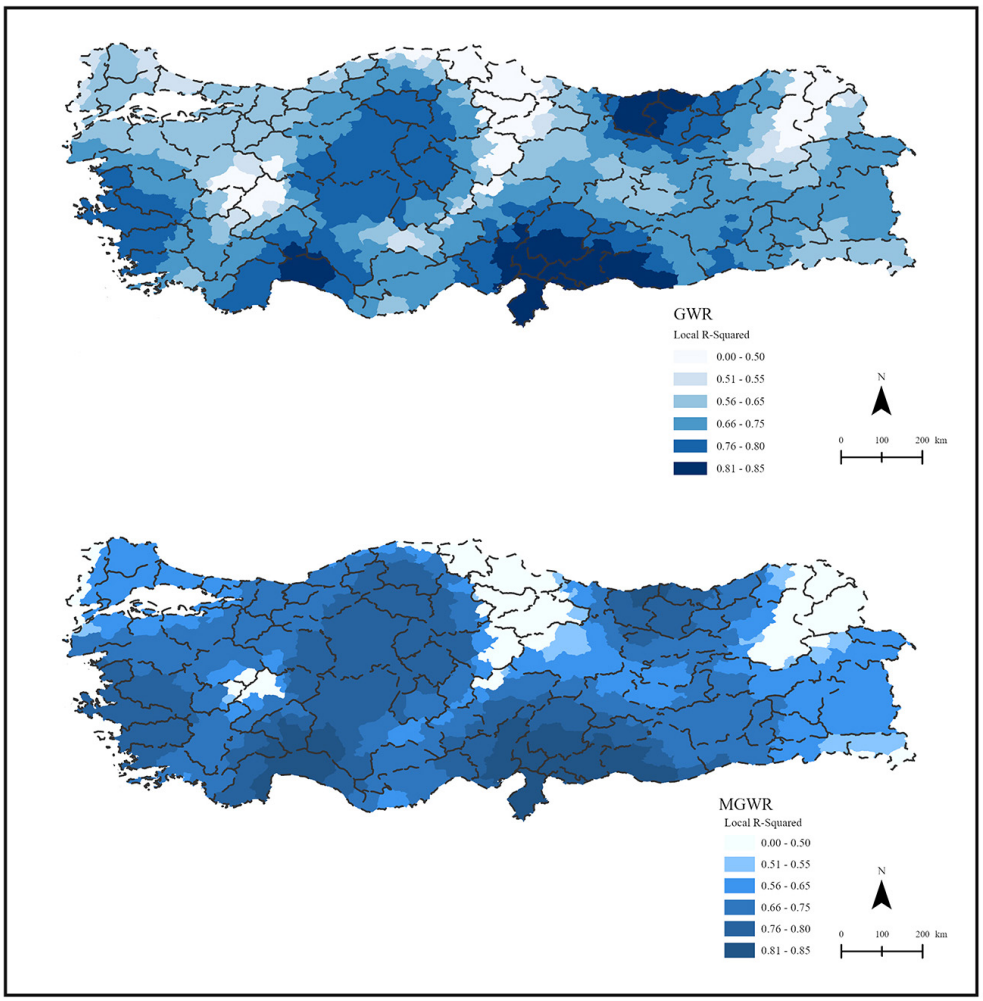


Figure 1. *Local R-sq of the GWR and MGWR models.*

greater than 0.7 and less than 0.5 in 138 districts (14.1%).

A comparison of the results for the coefficients and bandwidths (BW) of GWR and MGWR is shown in Table 4. The mean value of each coefficient reflects the association between that explanatory variable and the dependent variable. The standard deviation indicates the spatial variation of each explanatory variable. In that respect, comparing the mean values of GWR and MGWR, the two models give very similar estimations. The influence of the continuous urban fabric (Cont_urb) appears to be the highest in MGWR and GWR. The bandwidth of the GWR model is 234, whereas it varies between 120 and 603 in the MGWR model. The higher bandwidth of infrastructure (Inf) (the global scale variable) and the lower bandwidth of continuous urban fabric (Cont_urb) indicate higher spatial heterogeneity and microscale. Multicollinearity is also checked in the model results.

Table 4. *Summary of the statistics of GWR and MGWR*

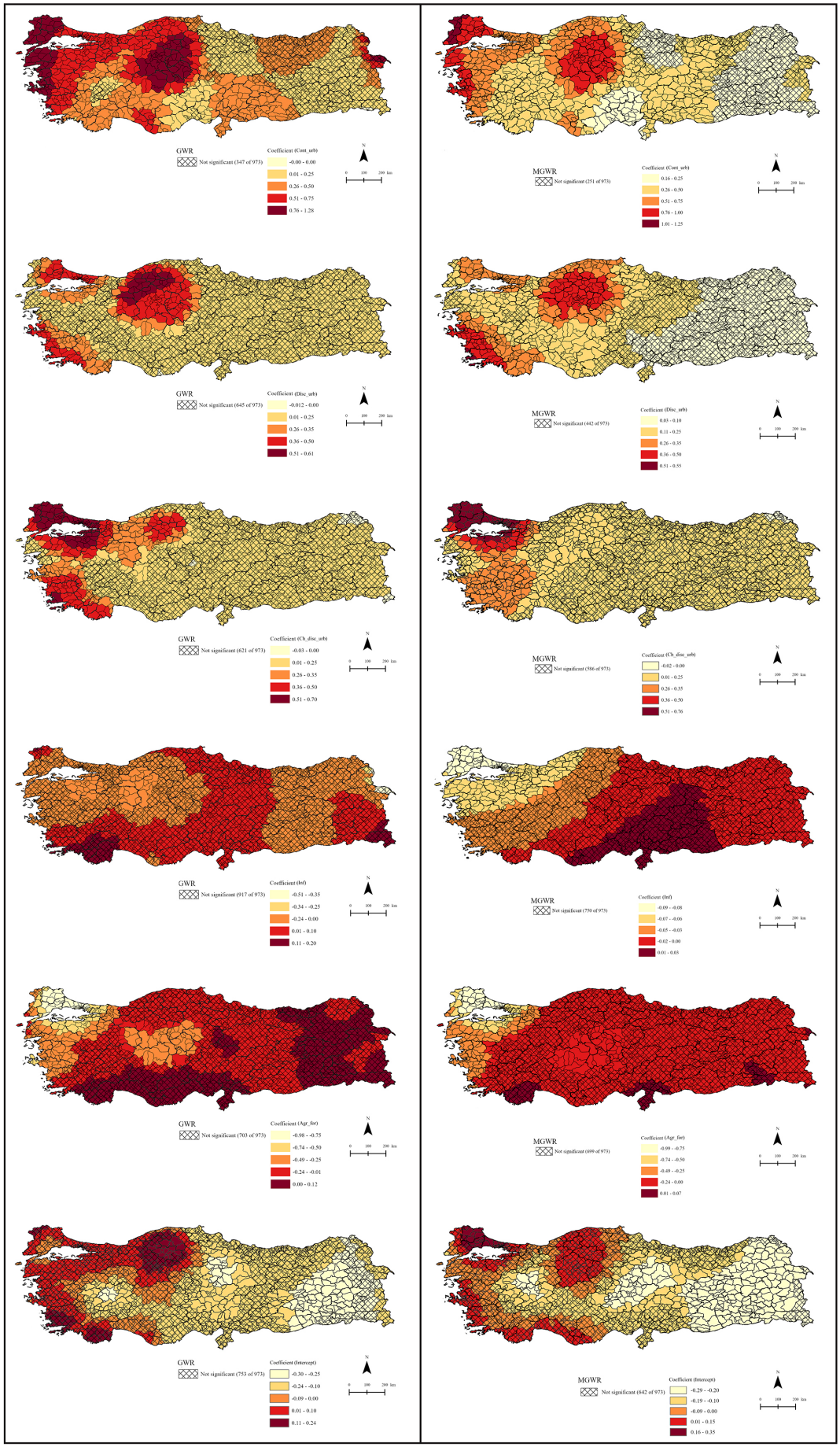
Coefficient of variables		**Intercept**	**Cont_urb**	**Disc_urb**	**Ch_disc_urb**	**Inf**	**Agr_for**
GWR	**Min**	-0.3	-0.00	-0.01	-0.02	-0.5	-0.98
	Mean	-0.09	0.46	0.19	0.2	-0.03	-0.16
	Median	-0.12	0.40	0.15	0.13	-0.01	-0.03
	Max	0.23	1.28	0.61	0.69	0.16	0.11
	Std. Err.	0.13	0.24	0.14	0.18	0.08	0.24
	BW	234	234	234	234	234	234
MGWR	**Min**	-0.29	0.17	0.03	-0.02	-0.09	-0.98
	Mean	-0.1	0.45	0.19	0.18	-0.03	-0.15
	Median	-0.15	0.36	0.19	0.14	-0.02	-0.06
	Max	0.35	1.18	0.55	0.76	0.02	0.06
	Std. Err.	0.13	0.22	0.11	0.16	0.03	0.22
	BW	234	120	250	234	603	420

Based on the local condition number of GWR and MGWR models being less than 30, multicollinearity is not observed as a violation of the models.

Figure 2 maps the coefficients of the GWR and MGWR models for the statistically significant variables. The coefficient estimates of continuous urban fabric (Cont_urb) have the highest significance share among other variables and vary across the study area. In both models, a significant regressor, the largest positive coefficient values in some areas, is associated with the continuous urban fabric, specifically within Türkiye's metropolises, such as Ankara, Istanbul, and Izmir. This reflects the effect of unauthorization on these metropolises' central districts, peripheral districts, and neighboring provinces. The higher coefficient values in the centers decrease towards the periphery in the form of a buffer but are still much higher than in the rest of the country. Although population dynamics are not included in this model, the increase in the continuous urban fabric may also be related to this issue.

The coefficients of discontinuous urban fabric (Disc_urb) are significant and higher in the tourist areas of Türkiye. Maps of the coefficients showed that the Aegean and Mediterranean coasts were significantly affected, and unauthorized housing formation was estimated. Change in the discontinuous fabric's (Ch_disc_urb) coefficient values and significance stand out with the severe impact of the Marmara region, where Istanbul is located. Between 2006 and 2018, the discontinuous urban texture increased where unauthorized housing was constructed. Similarly, the expanding effect from Ankara and Izmir reveals the decisive role of the increasing discontinuous urban fabric in the unauthorized activities along the corridor stretching from Istanbul to these provinces. The

Figure 2. *Parameter coefficients of GWR and MGWR*



fact that infrastructure activities (Inf) are high in certain districts, including along the Bursa–İzmir highway, can be interpreted as an increase in control by the state and a decrease in the areas likely to be developed. Infrastructure activities also negatively affect the construction of unauthorized housing to some extent, creating an obstacle to it. Ankara and its surroundings appear to have a similar tendency in this regard. Where the unauthorized housing prediction for agricultural and forest areas (Agr_for) is statistically significant, it is negatively estimated. For example, the plundering of Konya Plain is an important and distinct case, the destruction of forest areas along with agricultural areas in the whole of Marmara and the western Aegean areas are negatively estimated in terms of unauthorized housing units and increasing area reduction.

6. Discussion and conclusion

The discussion and conclusion of this study can be divided into two parts. Firstly, the model and its fit need to be focused on to explain the spatial distribution estimation of unauthorized housing. Like the other studies, this study also reached better model fit results in GWR and MGWR than OLS (Fotheringham et al., 2019; Li et al., 2022; Şenyel Kürkçüoğlu, 2023). In the comparison of the two local spatial regression models, MGWR with lower AICc is more explanatory than GWR. A best-fitting single bandwidth is defined in GWR, whereas several optimal values for each variable are estimated in MGWR. Using 234 as the unique bandwidth correctly classifies 71% of the observations in the GWR model, whereas bandwidths ranging between 120 and 603 in MGWR reached 73%. The increase in bandwidth also represents more global effect of EV on DV.

Secondly, there is an ongoing debate about unauthorized housing in Türkiye and its association with different planning mechanisms and urban/rural issues. The level and distribution of unauthorized housing have been frequently mentioned in bulletins and the national press. However, compared to such national estimations, the present study has the advantage of zooming in to reveal spatial fabrics at the subnational scale. It shows the potential of unauthorization in several districts of Türkiye. As expected, following the metropolitan cities, the coastal regions of Türkiye are the first to consider this problem.

6.1. Policy implications

With the zooming-in, Istanbul and its surrounding regions need elaboration regarding the risks and the future of unauthorized housing units. Most of these units do not have any construction or residency permits approving their structural stability and strength. Unconditionally authorizing these units can lead to a high risk of damage with an expected earthquake, including the whole Marmara region. To solve the unauthorized housing problem and physical environment problems in settlements, upgrading is also frequently called policy. Unlike unconditional legalization, with the authority's involvement in the upgrading, it is possible to encounter situations where risks are reduced, and conditions are improved in the living environment. As a result, changes in the quality of life for households are minimal when the goal is only to legalize, and the gravity of this situation becomes more apparent with the awareness that the total population of the Marmara region is 25 million. On the other hand, evaluating the number of calls regarding unauthorized housing concentrated in Hatay and its surroundings, together with the earthquakes that occurred in February 2023, reveals the importance of the results of this study.

Although the authorization of unauthorized housing has many negative aspects, it also has some positive. The most important of these is the legal status gained by tenant and owner-occupier households living in housing units that have gained legal status. The landlord does not pay any tax on the rent a tenant pays in an unauthorized housing unit because that housing unit does not exist in official records. However, with the authorization of housing, the landlord becomes subject to tax on both the rent and the number of real

estate s/he owns. Finally, the authorization of these units increases the number of housing units in official stock. This means that the discourse on housing deficiency can be eliminated for a while, and the focus can be moved to the qualifications of these units.

6.2. Further studies

Türkiye has experienced severe forest fires since 2020, which is outside our study's scope. If included, the coefficients of this land cover could be higher, indicating the excessive unauthorized housing in those areas. In addition to forests, unauthorized housing attempts destroy essential agricultural areas in Türkiye, such as Konya Plain and the Aegean region. In addition to the entire units, extensions and small shelters built in those areas should be controlled before irreparable destruction to the fields and olive groves. Notwithstanding, the legal construction in coastal areas of Türkiye has always been extensive, yet it seems that unauthorized housing also exacerbates this situation.

Lastly, the insignificant prediction and estimation for the Eastern regions may be related to two different scenarios. The first underlines the lower quantity of unauthorized housing there, the latter the low number of calls received by the Ministry from these districts. To sum up, for further detail, the number of variables and content of the study need to be expanded.

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