Mapping the Distribution Pattern of Gentrification near Urban Parks in the Case of Gyeongui Line Forest Park, Seoul, Korea

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Abstract: The objective of this study was to map the distribution pattern of gentrification, showing the adverse effect of urban parks. The study adopted the perspective that urban parks, which have thus far been featured in urban planning without much criticism, may actually bring about unintended effects. This study employed a theory of gentrification that has received increasing interest in urban sociology to investigate the other side of the gentrification phenomenon. We identified urban parks as the cause of the gentrification from the start, and verified and visualised the phenomenon in the case of the Gyeongui Line Forest Park. We determined that the area with the higher possibility of gentrification was that within 600 m of the park. Big data accumulated over the past decade were used to prepare a proactive, systematic procedure to address gentrification, which is materialising in diverse forms. Through this study, we contribute to debates on the environmental justice of urban parks. Small changes in urban space can strongly affect our healthy lifestyles and urban sustainability. From this perspective, our study's research process and its results could provide indications of how to structure and manage new urban planning projects in the future.

Keywords: gentrification; gentrification distribution pattern; urban park; Gyeongui Line Forest Park; environmental justice

1. Introduction

Urban parks have generally been considered places of welfare and public good that offer a variety of benefits to citizens. Studies on the effects of urban parks have mainly focused on the green effect such as reducing the heat island phenomenon and pollution abatement [1–3], or psychological perspectives such as restoration, satisfaction, and preference [4–6]. These studies highlight the positive environmental effects of urban parks, and have contributed to the development of urban parks and related fields. However, recently, urban parks' benefits have been called into question. They sometimes serve as places of delinquency, or remain unused as underdeveloped land. At times, a park may be a strategic tool that politicians use for their own benefit by employing the logic of development. It is not at all rare to see urban parks serving other purposes under the guise of the economic advantages of land use. In particular, there is growing criticism that the regional elite association Growth Machine, which promotes the issue of "growth" in urban development and redevelopment as the top priority for urban politics, has started to target urban parks [7]. As such, recent studies of urban parks are

demonstrating various attempts to grasp the diverse changes, social (change of neighbours, migration, etc.), economic (rise in real estate values, business turnover, etc.), spatial (combination and enlargement of space, etc.) and cultural (new culture, etc.) caused by the creation of urban parks. In particular, studies on the socio-economic changes to urban space resulting from the construction of the urban parks are regarded as crucially important in understanding the modern city of a free economic system, and related research is actively ongoing [8,9]. The discussions of urban parks that have been generated under these circumstances have been garnering increased scholarly attention as the major cause of gentrification in neighbourhoods, which has since been dubbed green gentrification [10].

Glass (1964) [11] was the first to introduce the term gentrification, and, since then, it has gained traction through numerous studies. The UK and US initially took the lead in this area, and various studies were carried out from different theoretical and experiential points of view. Gentrification is a concept used to describe the process of evolution of residential, commercial, and industrial areas in urban space. It has been defined as the 'transformation of an area into a middle-class neighbourhood as a result of the revival of the working class and abandoned houses' [12]. Glass pointed out that the original concept referred to the positive aspects of change in which the working-class districts of London started to be occupied by the middle class, with old shanty houses transformed into shiny new ones. Its meaning eventually expanded to include occupants and their activities within the central spaces of an urban area, problems related to the relationships between owners and tenants, and the displacement of existing occupants. In fact, there is still much controversy in the field of urban planning about whether gentrification is a positive or negative phenomenon.

In Korea, gentrification is emerging as a social issue, mainly focused on the fact that indigenous residents have recently been forcibly evicted. Here, it has become a common term that can be easily found in mass media, yet, by contrast, there are only a handful of articles or case studies available [13–16]. Specifically, much research is focused on the relationship between urban parks and global gentrification from various perspectives; however, there is still insufficient research into this phenomenon, despite witnessing its effects everywhere in Korean metropolises.

Recently, the Seoul Metropolitan Government (SMG) developed a policy map through the analysis of big data accumulated over the past ten years to help formulate proactive and systematic measures to address gentrification in its various forms. The map will monitor gentrification in different districts, predict its evolution in the near future, prepare proactive measures, and establish systematic urban regeneration policies. However, specific methods and results have not yet been discussed.

Considering this situation, it is necessary to study the process of gentrification phenomenon in urban spaces, especially around the urban parks.

Therefore, the goal of our study is to investigate the distribution pattern and zone affected by gentrification following the construction of an urban park. There are various existing studies on gentrification; however, they have not identified the exact variables that give rise to the phenomenon. Therefore, we found it necessary to draw mediators based on the definition and characteristics of gentrification in order to identify the variables that suit the objectives of our study. To achieve this goal, our research was performed over several steps. First, we examined the characteristics of gentrification that have been popular in recent discussions, and reviewed the correlation between urban parks and the creation of public space. Second, having established urban parks as the major cause of gentrification, we took the Gyeongui Line Forest Park, which has been blamed for the gentrification of the neighbouring area since its creation, as a case study, and mapped the distribution patterns of the sale prices of residential housing units. Lastly, we identified the potential zone most vulnerable to gentrification based on the distribution pattern of housing prices, and set a buffer zone to counteract gentrification in the future. We expect that our study will provide useful data for making gentrification-related policy recommendations to the SMG.

2. Gentrification and Urban Parks

2.1. Gentrification in Seoul

Gentrification has been the subject of heated socio-political debate of late. The discussion falls under three broad categories. The first concerns the different forms of gentrification, and the second asks what triggers it and how to explain its cause, the third and most active highlights the effects of gentrification, including its undesirable aspects. What is at stake in this issue is the extent to which the relatively poor, low-income strata are displaced by this phenomenon [17].

Hamnett (2003) [18] used the term 'double-edged sword,' claiming that gentrification had both positive and negative impacts on the city. A positive view of gentrification is that the local renewal effect revitalises the economy, such that the local government's revenues and finances are increased, a new class is introduced, and the social milieu is expanded. On the other hand, from a negative point of view, some of the resident population is forced to migrate as the price of real estate prices rise sharply, and the complaints and conflicts increase among residents. Gentrification in commercial areas promotes the upgrading of commercial facilities along lifestyle and consumption patterns that emphasise preference and aesthetics in line with the personalised consumption of gentrifiers, rather than general consumption. In this process, shops that reflect the identity and uniqueness of the existing merchants are reduced, transforming the sense of place. This leads to urban fragmentation. From the perspective of urban regeneration, gentrification is a dilemma that cannot negate the positive and negative parts.

It has not been long since researchers started analysing Korea, and particularly the spatial changes in Seoul, in terms of gentrification. Ha (2007) [19] pointed out the problem of the displacement and isolation of low-income residents that is the dark underside of increased stock values and enhanced quality of housing following redevelopment. He further argued that the process of gentrification favours landowners based on the principle that markets bring about the decline of the social and cultural capital of cities, and that it is not possible to pursue sustainable urban growth. In fact, the case studies on gentrification in Seoul tend to focus on the so-called 'new-build gentrification'.

In recent years, many areas of Seoul considered 'hot spots' have been somehow been involved with gentrification and its changes. For example, the Hongdae (Hongik University) area, Samcheong-dong, Insa-dong, and Garosu-gil Street are all areas generally considered to be gentrified. Areas of this sort continue to grow. Notably, here, the pace of development of an area from its initial change to the completion of gentrification is unprecedented in contrast to the West. Whereas it may have taken a decade or two in the past, lately, gentrification usually takes about five years, and in some cases, is completed in just two to three years. Therefore, it is difficult to prepare policy recommendations that can keep up with the pace of transformation. Hankyoreh (2014) [20] newspaper pointed out that gentrification took ten years in Insa-dong, Jongno-gu, Seoul in the 1990s, and five years in Samcheong-dong, Jongno-gu in the 2000s. On the other hand, the gentrification in Seochon in the 2010s was completed within two to three years, and the development was extremely rapid. Kyunghyang (2014) [21] newspaper criticised that the gentrification in Seoul takes place at a pace unmatched when compared to the West. The article remarked that gentrification in Hongdae and Daehak-ro took 20 years, while today it takes places in five to six years; thus, it is quite difficult to establish effective policies to counter the phenomenon.

In fact, gentrification in the international city of Seoul not only affects housing and commerce, but also culture and the arts, as artists are displaced and their infrastructure is destabilised. In general, artists with defiant spirits do not easily cooperate with existing urban policies, characterised as they are by resistance and rebelliousness. Considering the independence and autonomy of artistic communities that voluntarily settled in specific places, it is harder for them to adapt to urban development and gentrification aimed at the general revitalisation of the economy. Therefore, Kim (2014) [22] explained, it is important to continue to make efforts towards balanced discussion and cooperation between policy makers and artist communities in order to avoid branding, displacing, and commercialising artists in urban policy.

2.2. Ecological, Green, Environmental, and Super Gentrification

Studies identifying urban parks as the cause of gentrification have been around for a long time. Many large parks built in the past, including Central Park, were created to increase the value and development opportunities of the surrounding land, both publicly and politically [23]. Indeed, this pattern is similar in many countries in Asia, including China [24,25]. Urban policy strategies that have increased green space simply to increase the sustainability of a city, without the intentions of raising the value of real estate, have produced paradoxical results. [26]. Urban green spaces such as forests, green roofs, streams, and community gardens, as well as urban parks, provide important ecosystems within the city. This factor is related to health, which is one of the fundamental human rights, regardless of the value of real estate [27]. Recently, gentrification studies related to green space composition have been carried out mainly from the viewpoint of 'social justice,' focusing on the distribution of environmental goods rather than the flow of displacement and real estate values, which have been the main themes of gentrification. Recent studies have taken an interest in how environmental inequalities are being achieved, despite the large green space being created in the low-income communities. For example, Dooling (2009) [28] noted how planning to eliminate homelessness by creating a green space paradoxically attracted homeless people, bringing into question the meaning of homeless shelters in Seattle, WA, USA. He called this contradictory process 'ecological gentrification,' though it has been referred to in various terms by scholars because it is not yet an established discourse, unlike general gentrification such as green gentrification [29], environmental gentrification [30], or eco-gentrification [31]. It is clear, however, that this green gentrification displays not only the inequality of the socially underprivileged regarding access to environmental goods, but simultaneously reveals the typical negative effects of gentrification, such as community tensions and reduced social diversity. Therefore, studying the progress of green gentrification requires a dual perspective.

In recent years, there has been an increasing tendency to study the role of urban parks as a catalyst in the classic meaning of gentrification. Zukin (1987; 2010) [32,33], for example, pointed to Bryant Park in New York as an example of an urban park that triggered gentrification in the area. Bryant Park served as a living space for the homeless and jobless at night, and a place to rest for workers and residents during the day. The New York City government created the Bryant Park Corporation, inviting the big companies based around Bryant Park to be members and raising funds from them to carry out improvement projects. It emplaced private guards to establish order and security, and installed amenities such as a cafeteria. The small square inside the park also serves as a cultural space for small performances. Following these upgrades, the people who used to stay in the park at night were expelled, and the property values of the buildings surrounding the park dramatically increased. As the park was renovated, its users became more upscale; gentrification proceeded apace. The square eventually excluded the socially vulnerable classes, only providing space to suit the lifestyles and preferences of the privileged class.

Later, the High Line in New York became the impetus for a renewed discussion on the influence of urban parks on gentrification. Property prices on the west side of Chelsea, New York City, before the development of the High Line, were about 8% lower than average property prices in Manhattan. The West Chelsea area had a concentration of light industrial businesses, and was home to ordinary people. However, real estate values skyrocketed by 103% between 2003 and 2011. The city government and real estate developers welcomed this trend; however, this was not the case for the people who had been living and working in the area for decades. One car repair service suffered a 35% drop in income after the opening of the High Line, and another restaurant, which had been operating successfully for over 50 years, lost its regular customers and had to shut down [7].

Wolch et al. (2014) [9] described the High Line as a typical example of 'eco-gentrification'. Large-scale park construction projects become readily dependent on private capital, which, in turn, is more likely to result in confrontations between existing and new residents. He also pointed out that the park was not easily accessible for lower classes and ethnic minorities in the city compared to rich,

white residents, suggesting that urban spatial equality may collapse upon the construction of an urban park, and closely thereafter follows gentrification.

Similarly, Haffner (2015) [34], using the example of the High Line, pinpointed urban parks as one of the triggers of gentrification. He described how the High Line was the catalyst that changed the socio-economic conditions of the surrounding area, and how the subsequent hike in property values forced countless small businesses and low-income residents based around the High Line to move out. He pointed to this as a typical example of environmental gentrification, the phenomenon of native occupants being forced out of their homes due to an increase in real estate prices following large-scale urban green space projects.

Loughran (2014) [7] demonstrated the non-public, unequal utility observed in public space development projects such as the High Line based on the Growth Machines Theory. He stressed the fact that the High Line was a project created by a network of New York market elites in pursuit of economic gain, not in consideration of public interests. Therefore, he charged, the super gentrification that eventually took over after the creation of the park was the hidden intention of the elites all along.

As seen above, urban parks have been attributed with causing gentrification in various studies. However, it appears that sufficient evidence objectively establishing this causal relationship has been lacking. Therefore, our study analyses the Gyeongui Line Forest Park, which was recently completed upon the opening of its third phase, in order to objectively demonstrate this relationship. To do so, we visualised the distribution pattern to help identify the influence of gentrification in neighbouring areas.

2.3. Gentrification Mapping

As previously mentioned, existing studies on gentrification were largely theoretical and mainly based on the urban sociological approach. Recently, studies have emerged that aim to identify the characteristics of gentrification by mapping the phenomenon.

Chapple (2009) [35] analysed government housing, demographics, employment, transportation, land use, and policy data for ten-year intervals from 1990, 2000, and 2013 to derive the gentrification map. To proceed with the study, the project makes a clear distinction between gentrification and displacement, even though the definitions are often used interchangeably. The project defines gentrification as a demographic or physical change, such as a rise in wealthier residents or in neighbourhood investment. On the other hand, displacement was defined as a loss of low-income residents, the one criterion on which most research agrees. The project found that displacement followed gentrification and perhaps contributed to it in some parts of the San Francisco Bay Area, CA, USA. Maciag (2015) [36] analysed demographic data from the US's 50 most populous cities to assess how gentrification has reshaped urban neighbourhoods. Changes in several measures, described below, were calculated for each city's census tracts and compared to others throughout metropolitan areas.

The trend in studies of gentrification up to the present has been to look at it mainly from a demographic perspective. Most of the literature has investigated phenomena such as displacement caused by income gap and wealth inequality with a macroscopic approach towards the city. Far fewer studies have tried to microscopically visualise the distribution and characteristics of gentrification in urban spaces. In order to map gentrification based on the previous studies, it is necessary to integrate the data and to analyse them systematically to enable future prediction. In particular, it is necessary to analyse and visualise the detailed urban information on main streets, buildings, and land prices of an area at a microscopic scale. Therefore, in this study, we analysed the plot-based data based on the massive quantity of data accumulated by the SMG, and conducted a spatial analysis to visualise the results.

3. Research Methodology

3.1. Study Site

The study site for our research is the area surrounding the Gyeongui Line Forest Park, which has just recently been completed. It is a linear park that stretches over 6.3 km. When the Yongsan Line,

a branch railroad in Seoul, was closed following the Gyeongui Line double track project, and extended metro stations were constructed along with the Incheon International Airport Express, the necessity for effective planning and management arose in order to prevent sprawl over the disused railway site. The park is the result of a construction project carried out as part of this effort. Gyeongui Line Forest Park was gradually opened, phase-by-phase, over different periods. Therefore, it was deemed that the park would be a desirable site for our study objective of investigating the degree of influence of the creation of an urban park.

The construction was initiated through the signing of an agreement between the Korea Rail Network and the Mapo-gu Office in 2007, followed by the 'research project for Gyeongui Line basic survey and planning' in 2008. The construction of the first phase of the park (from Daeheung station to Gongdeok station) was completed in 2012, and the second phase (Saechanggogae, Yeonnam-dong, and Yeomri-dong) in 2015. The third and final phase (Changjeon-dong, Sinsu-dong, and Wonhyo-ro) was finished in 2016 (Figures 1 and 2).
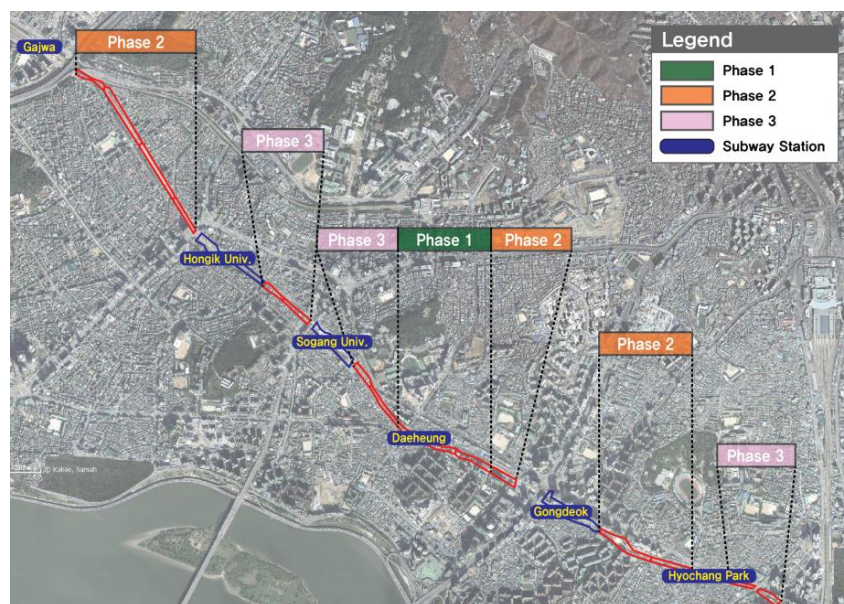

Figure 1. The construction process of Gyeongui Line Forest Park [37].

Figure 2. General landscape of Gyeongui Line Forest Park.

3.2. Data Mining for Defining Gentrification with House Transactions Data

Here we defined here gentrification term as an extreme increase in housing prices with the assumption that the native occupants are having difficulties in continuing to live there because of the high prices. Data on changes in housing costs were produced by combining the parcel information (PNU code) and spatial data (serial cadastral map) of the data on housing sale prices from the data on real trade prices of residential properties (2010–2015), which had been previously determined as the source of gentrification. We used the data of housing property sale prices to see the changes over time series. The public data on house prices from the SMG and cadastral map information from the Ministry of Land, Infrastructure, and Transport were used (Figure 3, Table 1).
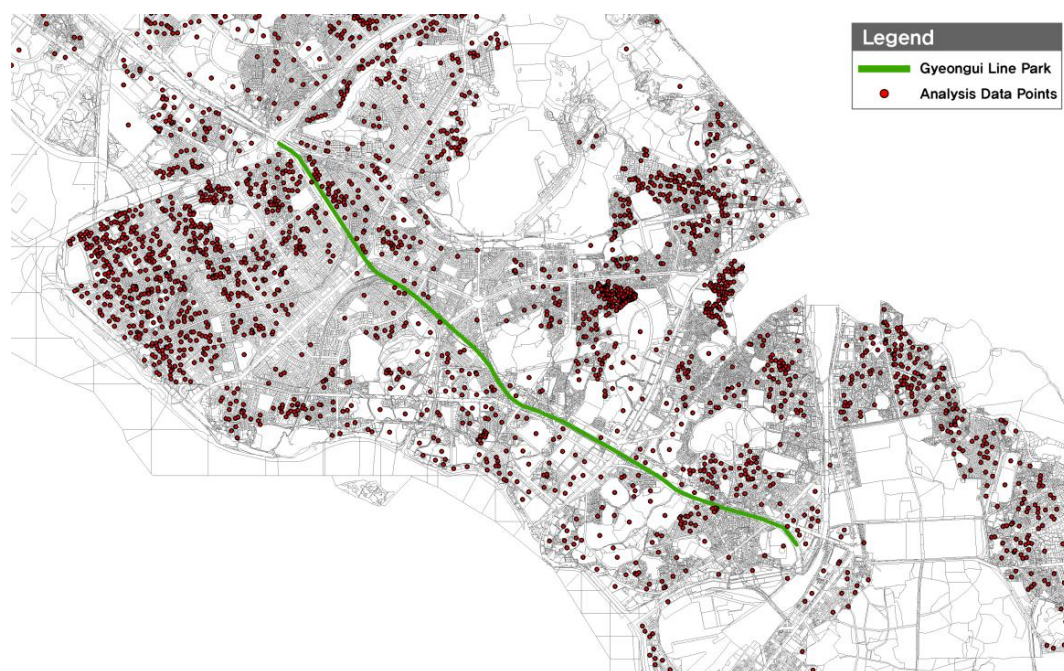

Figure 3. Gyeongui Line Park and analysis data points.

Table 1. Utilised public data.

Division	Public Data	Temporal Scope	Source
Spatial Information	Cadastral Map and Registered Building Data Information series [38]	2015	Korea National Spatial Data Infrastructure Portal, Ministry of Lands, Infrastructure and Transport
Housing Data	Aggregate Building Materials, Real Sale Prices of Housing (Trading) Materials [39]	2010–2015	Public Data, Seoul Institute

House price change ratio was calculated using Equation (1).

$$R_t = \frac{HTP_t - HTP_{t-1}}{HTP_{t-1}} \tag{1}$$

where, R_t = House price change of year t, HTP_t = House transactions price of year t, t = year.

In order to reduce errors in the mapping of the results of the distribution pattern, the average rate of change of price per surface area in housing property sales in a given year was calculated, and was used in cases where there was no data in the same year when there had been in the previous year (Table 2).

Table 2. Generation of analytical data.

	Division		House Price Change Compared to Last Year				
FID	PNU Code	Address	2010–2011	2011–2012	2012–2013	2013–2014	2014–2015
0	1117010100100010000	11, Huam-dong	0.6667	1.4350	1.0767	1.0439	1.0752
1	1117010100100010000	15, Huam-dong	1.0038	1.0250	0.8293	0.9118	1.0752
2	1141011700100060000	5, Yeonhui-dong	0.9727	0.9656	0.9758	1.0439	1.4865
3	1144012000102470000	88, Seogyo-dong	1.0038	0.7609	0.9758	1.0439	1.0752
4	1144012400102540000	7, Yeonnam-dong	1.0038	0.9656	0.9758	0.8214	1.0752
5	…	…	…	…	…	…	…

3.3. Spatial Mapping and Buffer Analysis

Housing prices are not determined independently in a particular area, but are rather determined according to changes in various conditions in neighbouring areas and through mutual influences. Therefore, interpolation was deemed most suitable for mapping the distribution pattern of residential housing prices in this study. House price change of year (t) compared to year ($t-1$) was used in the interpolation process. We generated the distribution pattern of changes in housing sale prices in a time series. The areas with greater change are considered to have a higher probability of gentrification.

The Kriging interpolation method, particularly the ordinary Kriging method and Spherical Semi-variogram model, of mapping, were used in this study to map the process of gentrification. Kriging is an advanced geostatistical procedure that generates an estimated surface from a scattered set of points with z-values.

We also created multiple buffers at 100 m distances up to 1000 m around Gyeongui Line Park by construction project phases 1, 2, 3. With the ArcGIS Zonal Statistics tool (version 10.1, ESRI, Redlands, CA, USA), average price changes were calculated for a multi-ring buffer zone, based on values from interpolation results. A single output value was computed for every zone in the input zone dataset.

3.4. Defining Gentrification Distance and Hot-Spot

The influence of the Gyeongui Line Forest Park was examined according to the order of the opening of each phase of the park to determine the changes in housing prices caused by each phase. We extracted extreme change areas with over 99% confidence intervals of population mean. We used Equation (2) for defining gentrification distance, called the Base Ratio of Gentrification Area (BROGA). We then matched the multi-ring buffer average value of house price change with the extreme value of house price change by project phases.

$$\text{BROGA} = \overline{X} = +2.58 \times \frac{\delta}{\sqrt{n}} \tag{2}$$

where sample mean is $\overline{X}$, sample standard deviation is δ, and sample size is n.

We overlapped the spatial map of house price change ratio of each year to find the hot spots area of gentrification.

4. Results

4.1. Mapping the Distribution Pattern of Real Estate Transactions

In order to examine the relationship between the changes in housing sale prices and the opening of the Gyeongui Line Forest Park in its major project phases, a buffer analysis was conducted horizontally from 100 m to 1000 m, at 100 m intervals, according to the order of opening of the phases of the park (Figures 4–6). Results showed that changes in residential property prices around the park were in accordance with its opening periods. Further, the areas with greater proximity to the park demonstrated higher rates of change in housing sale prices, and the trend reduced as the distance from

the park grew. Similar trends were observed in each phase; therefore, it can be said that the impact of the park construction increases with proximity to the park. One point worth mentioning is that the changes in residential property prices in the third phase of the park showed an overall inverse proportion according to proximity. The analysed R^2 value of the phase 3 of the park is relatively lower than that of the first and second phases. However, statistically, it is generally considered to be suitable when R^2 is 0.26 or higher [40]. Thus, the results of our study are statistically significant. However, the prices in the third phase showed a steep increase in the 300–400 m range, unlike in other phases. The planning and construction of a large-scale residential complex were completed in this period, which generated sales around the Sogang University area close to the third phase of the park. The inversion is thus understood as a phenomenon affected by the Sogang area functioning as an influential factor over trade volume in housing property sales. Multiple newly developed areas are scattered around the park, and only those that were thought to influence the buffer analysis results are shown in Figure 6. This situation represents a general phenomenon that could be found in any complex modern metropolis. If there were no developments in the vicinity, the map would show a linear graphical characteristic similar to phases 1 and 2.
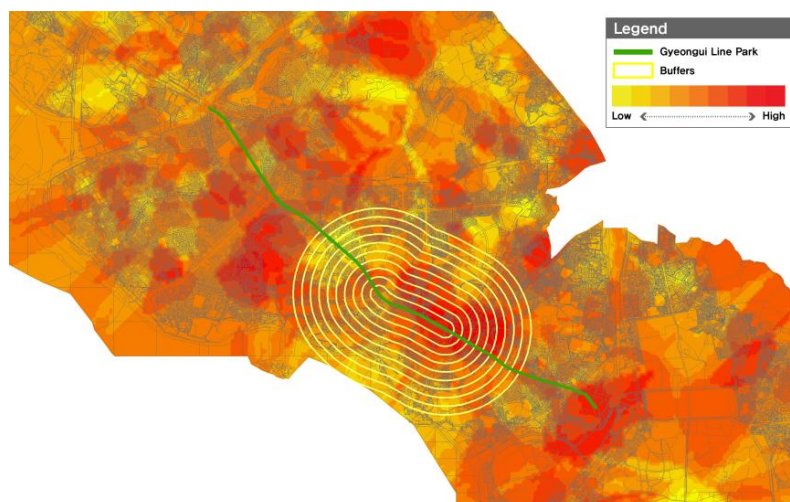

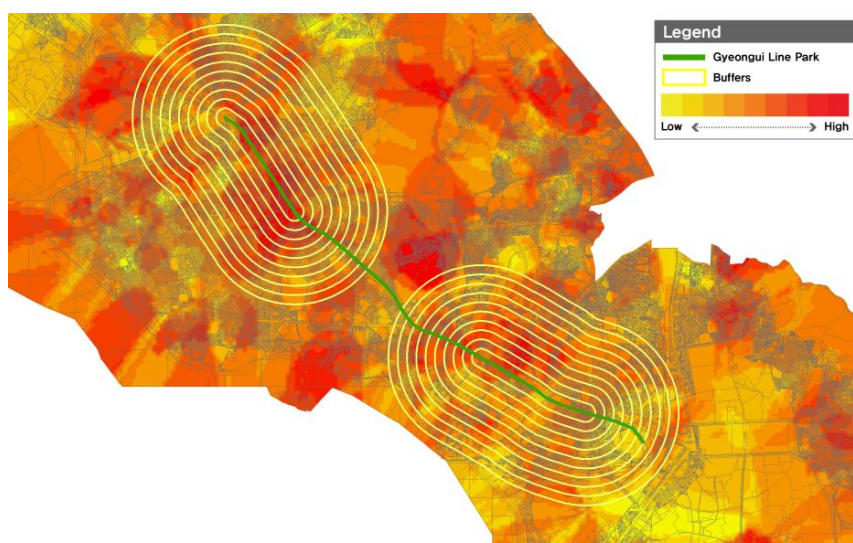**Figure 4.** Rate of change of real estate transactions (phase 1, 2011–2012).

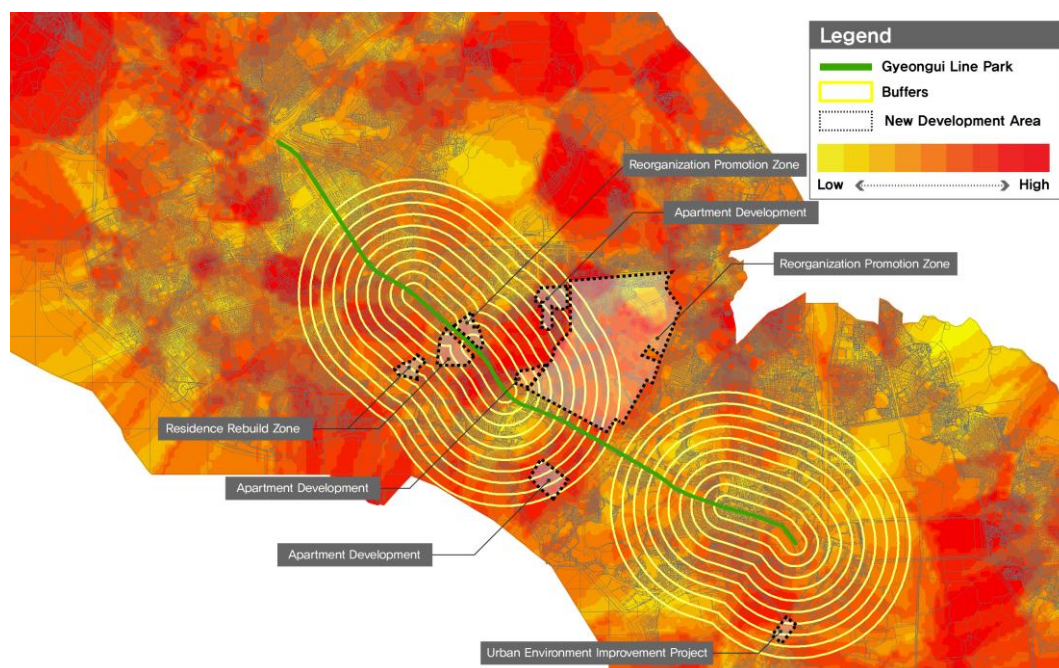**Figure 5.** Rate of change of real estate transactions (phase 2, 2013–2014).

Figure 6. Rate of change of real estate transactions (phase 3, 2014–2015) and new development area.

Additionally, the degree of change was relatively higher as proximity to the park increased (maximum 5% or higher), in comparison with the changes in housing sale prices per buffer for a given year, and the average total change in housing property sale prices for the year. These results demonstrate that the construction of the park had a great influence on housing property sale prices in the neighbouring areas (Table 3, Figures 7–9).

Table 3. Rate of change of real estate transactions by Gyeonui Line Park phases.

Division		Period	Division		Period	Division		Period
Phase	Buffer (m)	2011–2012	Phase	Buffer (m)	2013–2014	Phase	Buffer (m)	2014–2015
	100	1.0179		100	1.0804		100	1.0862
	200	1.0156		200	1.0727		200	1.0932
	300	1.0072		300	1.0678		300	1.0993
	400	1.0007		400	1.0640		400	1.0999
	500	0.9849		500	1.0601		500	1.0906
	600	0.9630		600	1.0568		600	1.0902
1	700	0.9438	2	700	1.0509	3	700	1.0885
	800	0.9380		800	1.0443		800	1.0735
	900	0.9352		900	1.0416		900	1.0620
	1000	0.9350		1000	1.0357		1000	1.0643
	Ave. *	0.9656		Ave. *	1.0439		Ave. *	1.0752
	S.D.	0.1313		S.D.	0.1528		S.D.	0.1985
	Sample Mean **	0.9714		Sample Mean **	1.0506		Sample Mean **	1.0839

* Avg. of all real estate transactions from the data; ** positive 99% confidence interval mean for all data.

The fact that there were significant changes in the housing property sale prices according to proximity to the Gyeongui Line Forest Park may be an important factor in explaining changes in future rental prices in the areas surrounding the park. Rental prices were not analysed in this study due to limitations in data accessibility, but it is thought that the rental prices must have increased in a similar manner considering the influence of housing sale prices on rents. It is necessary to analyse this

relationship with rental prices in future studies. We expect that the mapping of the changes observed in housing sale prices in this study will serve as a model for identifying potential areas of gentrification.
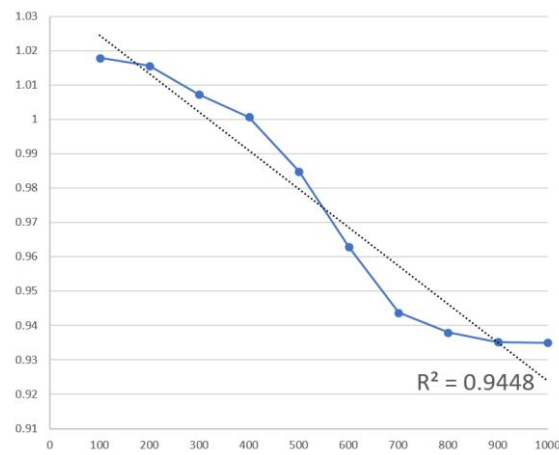

Figure 7. House price change rate by Multi ring buffer at 100 m distance in phase 1 (2011–2012) and R^2.
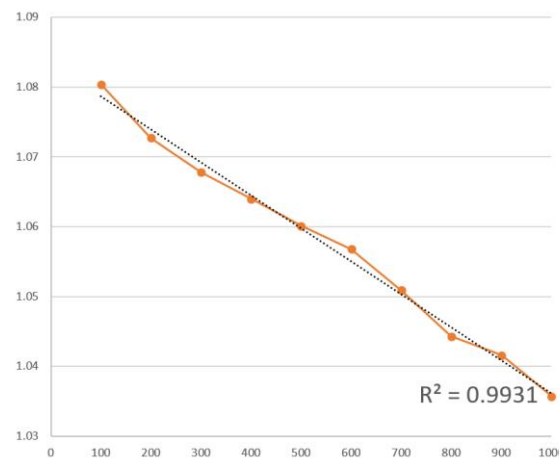

Figure 8. House price change rate by Multi ring buffer at 100 m distance in phase 2 (2013–2014) and R^2.
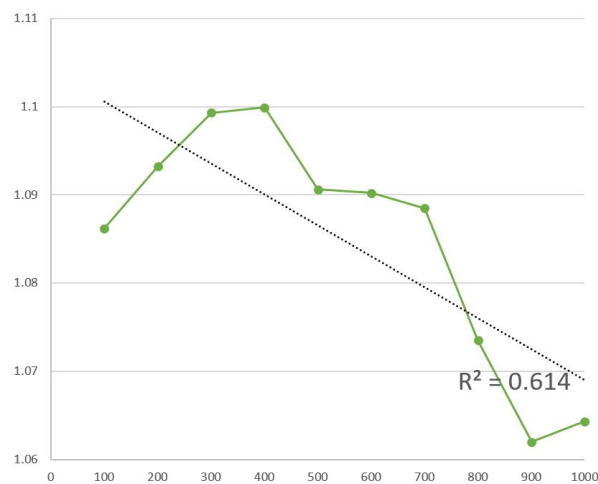

Figure 9. House price change rate by Multi ring buffer at 100 m distance in phase 3 (2014–2015) and R^2.

Based on the above analysis, the impact zone, the area with the greatest change in housing property sale prices caused by the park, can be set. In examining a sample mean within the 100–1000 m range with a 99% confidence interval, the area within 500 m in phase 1, and within 700 m in phases 2 and 3 were positively related with the Gyeongui Line Forest Park. This indicates that the influence of the Gyeongui Line Forest Park over real housing sale prices extends out to about 500–700 m. There is also a chance that the prices around this area may increase much further than the average rate of change of housing prices. With reference to the study by Seoul Development Institute (2007) [41], which defined 400–600 m as an average walking range, and a study by Kim et al. (2010) [42], which set 600 m as the buffer zone for the walking range around a subway access area, which was deemed a walkable distance reachable within 10 min, 600 m is widely considered a reasonable range for the zone affected by changes in housing sale prices due to the park.

4.2. Determining Areas of Potential Gentrification by Mapping Housing Property Prices

Based on the previous results of mapping the zone affected by housing sale prices, areas near the park that are vulnerable to gentrification were identified. Only values above the average housing sale prices of each year were extracted, and then overlayed. Those that overlapped three or more times were identified as areas with a higher possibility of gentrification over other neighbouring areas (Figures 10 and 11). From four or more times of overlapping, the average housing sale prices in the entire area of the 600 m buffer zone were mapped. In order to identify areas with a strong probability of gentrification, the number of overlaps was set at three. Through mapping, the areas with the highest possibility of gentrification caused by the park were identified as those located within the maximum impact zone of 600 m: Yeonnam-dong of Mapo-gu, Seogyo-dong, Seongsan1-dong, Seongsan2-dong, Seogang-dong, areas around Sinsu-dong, Sinchon-dong of Seodaemun-gu, areas around Daeheung-dong, and areas around Yongmun-dong of Yongsan-gu (Figure 12). Considering the fact that gentrification usually takes place in areas with cheaper rents, it can be concluded that it usually happens in residential areas consisting of smaller lots. For this reason, we did not mention the areas covered with apartment complexes on large lots as areas of strong gentrification. These results correspond with the areas where problems caused by gentrification along the park have recently been observed and reported by various news media [43–45]. Altogether, the estimated area of gentrification found through overlaying the mapping results of housing sale prices is considered reasonable.

Figure 10. Overlay of the avg. rate of change of real estate transactions (2010–2015).
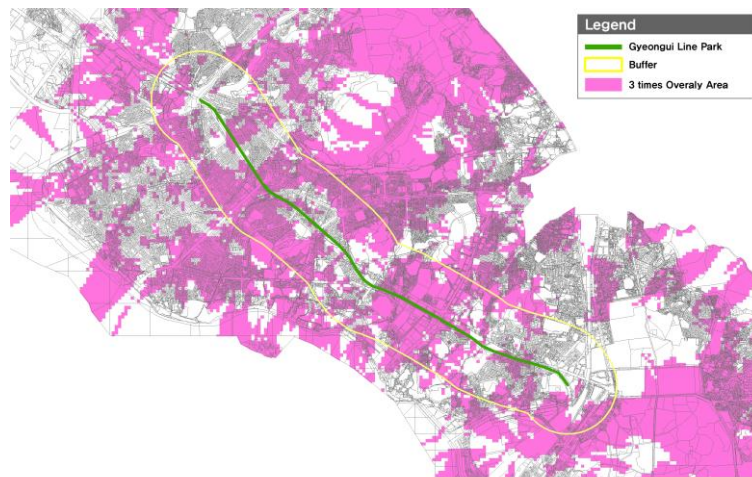
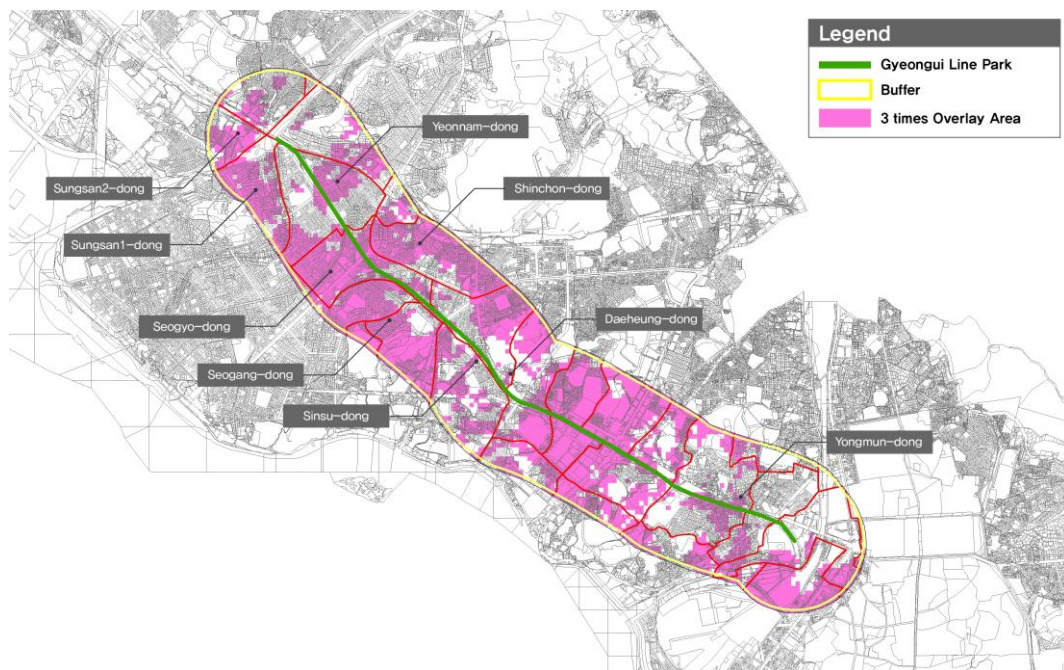**Figure 11.** Three times overlay of the avg. rate of change of real estate transactions (2010–2015).

Figure 12. Three times overlay of the avg. rate of change of real estate transactions within 600 m Buffer (2010–2015).

The area with the widest range of gentrification, observed in Figure 12, had a strong commercial base as a university area. As can be seen on the map, its influence has now expanded far wider due to the existence of the park. On the other hand, the areas where gentrification was not marked on the map despite their proximity to the park were mainly surrounded by residential areas. The expansion of gentrification implies that the phenomenon can also be triggered by an existing commercial area.

5. Discussion and Conclusions

Our study investigated the paradoxical phenomenon of gentrification caused by urban parks using the rate of change of housing sale prices as a mediator in order to find out whether an urban park really is a cause of gentrification, and, if so, what the range of its impact is and how far it can reach. The significance of our study is that it delves into one of the less beneficial aspects of urban parks—which has not yet received critical attention in urban management and planning—by exploring

the phenomenon of gentrification that has recently garnered much interest from urban sociologists. In addition, visualisation of the gentrification phenomenon depicted in building units is a valuable new contribution of this study.

Study results show that the Gyeongui Line Forest Park was indeed the cause of the changes in local housing prices, and the impact zone was calculated to be a maximum of 600 m. Yeonnam-dong of Mapo-gu, Seogyo-dong, Seongsan1-dong, Seongsan2-dong, Seogang-dong, areas around Sinsu-dong, Sinchon-dong of Seodaemun-gu, areas around Daeheung-dong, and areas around Yongmun-dong of Yongsan-gu within the 600 m zone were identified as the areas with a high possibility of gentrification due to the construction of the park. Additionally, they are all surrounded by well-established commercial areas.

The process and results of this study will be relevant for the Seoul Metropolitan Government (SMG) in the development of its policy map for the analysis of big data obtained over the last ten years with the objective of enhancing proactive and systematic responses to gentrification in its various forms. In particular, the zone affected by gentrification, identified as about 600 m, corresponds with the range of normal walking distance. This can practically contribute to formulating comprehensive management policies for neighbouring areas around urban parks following their construction. When a new urban park is planned in the future, our study will serve as a reference to set the proximity that requires management to prevent the negative effects of gentrification.

Thus far, only the positive, short-term aspects of the construction of parks for urban regeneration have been considered important, such as regenerating the community and enhancing its image. The fact that our study objectively demonstrates that these parks may bring about unintended effects, including gentrification, as they lead to increases in residential rental or property sale prices, holds profound implications for urban sustainability from the perspective of environmental justice.

Still, there were a few limitations to our study. First, only the rates of housing sale prices were reflected in identifying areas of potential gentrification. The data on real trade prices of housing properties used in this study are public data produced based on the data registered at the land management department of the SMG. However, it is important to maintain some doubt about the reliability of the data considering the characteristics that individual traders report them only after the deal has been made. Considering the definition and characteristics of gentrification, the rate of change of housing sale prices is an important variable. However, clearer gentrification mapping results will be produced if more diverse variables related to real estate (commercial building rents and premium fees) and demographics of the area (occupation, age, and type of business) are taken into consideration. In the meantime, the Seoul Institute will continue to accumulate and provide data on the diverse variables. Unfortunately, their data have scales differing from one another. For example, data on housing sale prices are organised for individual buildings, but the variables' related demography are analysed by region. This makes the comparative study of mutual relations impossible. Therefore, it was not possible to utilise the data for analysis in our study. If the demographic data would be accumulated by building units in the future, more accurate gentrification mapping results can be produced. Second, the study site was limited to the Gyeongui Line Forest Park. The neighbouring areas are part of Hongdae, which has a number of diverse changes already in progress. Therefore, there is a risk of generalising our study results, as there may be other variables that played a part in gentrification in addition to the park. In future research, more data should be accumulated concerning rental prices related to commercial facilities, such as neighbourhood living facilities, other real estate values and types of properties that are traded, as well as the annual survey on demographic statistics for each building. These should provide sufficient data to more accurately map gentrification by calculating the weight of the mapped sections.

Based on the results of this study, there are some issues to be discussed.

The first regards urban parks and gentrification. As we have seen in previous studies, it was found that there is tension in the relationship between urban parks and gentrification, and this study provides some verification of this point. Thus far, only the positive aspects of urban parks, such as

green effects and restoration, etc., have been emphasised, which means the arguments and results of this study may be controversial. Such debates indicate that some may have a problem accepting the results of this study, depending on whether they place significant value on either human health or urban health. Any choice is like a double-edged sword, but there is no doubt that urban parks are certainly important urban planning facilities that enrich a city. Still, it is necessary to consider social phenomena such as the gentrification in the planning of urban parks. If the discussions generated by this study continue, they could help in the development of a more ideal city.

The second topic relates to the urban park gentrification effect buffer. Based on the results of this study and some references related to this issue, it can be assumed that the gentrification buffer zone influenced by urban parks would be set at about 600 m. The controversy is why we should set the impact zone at 600 m. Perhaps proposing a bill to the residents of the probable gentrification district could encourage additional taxes, development coordination, and participation in the operation and management of urban parks. Without such policy implementation, residents in the surrounding area may not make any effort to create such public spaces as urban parks in their city. However, it goes without saying that public green spaces have proven to have some socio-economic benefits. Of course, the accumulation of property in the free market economy system due to the rise of real estate values is a natural and a fundamental right recognised in the constitution of the democratic state. Even so, it is not the time to simply assign blame for these benefits. This viewpoint provides not only important implications for restoring the health of urban society, but also of the environment. The gentrification buffer zone proposed in this study could be a turning point for social responsibility, spatial equality, and social consciousness for urban residents. By applying this buffer, social problems caused by urban parks could be solved in terms of environmental justice. It must therefore be noted that 600 m remains a matter of discussion. Although it seemed reasonable to apply the 600 m impact zone of urban parks as has been done in various other studies considering average walking distance to be 600 m, the influence of the phenomenon of gentrification could diverge from the walking range and be subject to the varying characteristics of each environment. Therefore, the buffer distance has the limitation of generalisability. However, considering that this is the first study to establish the distance, it remains open for discussion whether this is in fact a limitation. Therefore, in order to obtain an accurate, generally accepted distance, a more focused and detailed study should be carried out as the starting point of the next study.

Gentrification and the fight against it, which have been taking place for a few years now in Seoul, have entered the phase that accelerates competition and negotiation over sociality (or social value) and publicness (or public value) beyond the level of a simple game between people (mainly owners and tenants). The neutral vocabulary referring to this competition and negotiation process is 'urban regeneration,' and the construction of parks for the public good is considered to be one of its most essential elements. The SMG is now recruiting private developers for park facilities that have not been renovated for a long time, as the regulations on the 2020 long-term underdeveloped urban facilities have been lifted. In this context, it is expected that more parks will be constructed by private development, which prioritises corporate profits. The areas surrounding such urban parks will have a higher risk of gentrification.

Our work presents a basic case study for predicting gentrification following park construction in the future. The previously mentioned cases of green gentrification, such as the High Line, Bryant Park, and others, as well as Korean examples have yet to yield concrete solutions. Many approaches may be possible for each case, but there is still no research that suggests a specific range of precaution, as in this study. Thus, the methods and results of this study could clearly suggest a solution to the problem. It makes a valuable contribution to the development of broader and more comprehensive studies of gentrification through investigating more diverse variables, including rental prices. At this point, our study may help in identifying the characteristics of gentrification for expected urban park projects around the world in the near future, in mapping the gentrification phenomenon, and in preparing a proactive prevention policy.

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