Do urban renewal programs make suburbs safer? A fine-grained GIS and space syntax study of an urban renewal project in the city of Toulouse

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ABSTRACT

This paper evaluates the impact of urban renewal programs (PRU) on creating a safe environment. People's perceptions of PRU and its impact on security were collected through questionnaires and sketch maps. This study applies a space syntax approach to analyse the spatial and structural properties of successive urban space evolutions and compare them with people's perceptions of secur-ity. The findings reveal a strong correlation between areas with high levels of social housing concentration, poverty rates and insecurity. Surprisingly, visually controlled areas are vulnerable and attractive locations for drug trafficking. Density indicators have a minor influ-ence on the perception of insecurity.

KEYWORDS

Urban renewal program (PRU); security vs. insecurity; space syntax; density; accessibility; visibility

Introduction

European cities have long experimented with urban renewal strategies to overcome urban decay and enhance quality and security issues (Roberts and Sykes 1999). Ensuring urban safety is an essential and continuous component of urban sustainability that requires effective planning approaches to reduce crime fear and enhance communities' liveability (Ceccato 2016; Hawken et al. 2020). However, urban renewal programs may result in the creation of unanticipated, challenging, difficult-to-control and insecure spaces. Furthermore, it is not only unsafe places but also the perception and fear of crime that reduce urban liveability. This, in turn, can contribute to physical and social disorders, leading to more serious crimes (Pánek 2018), and influencing individuals' decisions regarding residing in or avoiding specific areas (German et al. 2022). Large modernist housing estates are an example of such failures and have become the epicentre of concentrated poverty, crime, drug-related and other social issues. They were, and often still are, labelled as problematic 'dreadful-sink estates' in both design and social terms by politicians, the mass media, and academics (Watt and Smets 2017).

French urban renewal programs (PRU) were launched in 2003 with the official project goals of enhancing the housing condition of sensitive urban zones (ZUS), through de-densification, and creating a safe and secure housing development. -

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https://doi.org/10.1080/13574809.2024.2334748

reducing the socio-spatial inequalities between territories and reinforcing their attractiveness. -combating social exclusion by promoting social mix and creating mixed-income housing and openness to the city (Godillon 2012). Moreover, prevention remains a major issue linked to city policy, as insecurity reduces the area's attractiveness and jeopardizes urban renewal programs. PRUs show the growing influence of security-related issues in urban renewal and city policy (Belmessous 2011).

However, urban renewal is still a controversial and broadly discussed programme, criticized for its neoliberal nature, causing displacement and social cleansing (Watt and Smets 2017). Other scholars argue that urban renewal demolitions and relocation initiatives seem to have positive effects on reducing violent crime (Alonso, Andrews, and Jorda 2019). There is ongoing academic and policy debate regarding the effectiveness of these programmes in achieving their goals of promoting social mix, and spatial justice, as this may lead to new socio-spatial inequalities, and insecurities (Cozens 2011).

This research evaluates the effectiveness of urban renewal program (PRU) goals in enhancing urban security. The study was conducted during (2021–2022) in two suburban priority neighbourhoods undergoing these programmes in 'Grand Mirail'. The district is considered one of the most unsafe large housing estates in the city of Toulouse.

Despite the PRU efforts, crime rates in the area have continued to rise compared to previous years (Gendarmerie Nationale CGD 2019), particularly drug trafficking, contradicting the data presented in the official police reports. The increasing crime rates questioned the effectiveness of PRU initiatives in achieving security-related objectives and creating safe environments. The research aims to identify potential spatial and social configurations contributing to the issues and explore possible solutions through new developments and architectural projects.

Evaluating the urban renewal initiatives' impact on urban security is challenging due to the absence of pre-implementation diagnoses (Gosselin 2015). Limited researches exist on the effectiveness of these programmes in the French context, with a focus on local-scale policies, stakeholders perspectives (Bourret 2019), mobility and trajectories of relocated populations and housing diversification (Férial et al. 2010), population mobility housing prices (Chareyron, Goffette-Nagot, and Letrouit 2022), built environment changes and population dynamics (Guyon 2016), living conditions in disadvantaged neighbourhoods (Lévy-Vroelant 2007), and pedestrian mobility and road safety (Godillon 2012). However, there is lack of study on the perception of security and fear of crime at the street unit and network levels, as well as the influence of urban layout on daily life and criminal behaviour. Gaining such knowledge would be valuable for crime prevention and informing city policy decisions.

The research methodology involves a dual approach combining: (1) qualitative evaluation of residents' perceptions of urban renewal programs, particularly in terms of the security (i.e., through a questionnaire survey and sketch maps), (2) space syntax study that evaluates the structural and visual properties of urban spaces before and after the application of the PRU (Hillier 1996). The results from the spatial and visual analyses, density, and socioeconomic data and local people's perceptions of security are compared. The aim is to examine the impact of spatial configurations and urban improvements on security perception and to understand how these perceptions influence resident's behaviours after PRU.

French urban renewal programs

The French national housing policy initially aimed to address the housing shortage in the 1960s by constructing large housing estates, known as 'Grands ensembles', based on modern urban planning principles, on the outskirts of cities. However, within less than two decades, it proved to be unsustainable and was ended by 1973. This resulted in a significant population decline, attributed to changing migration patterns, increased home loans accessibility, and government policies favouring home ownership (Tuppen and Mingret 1986). Middle-class residents abandoned these priority urbanization zone neighbourhoods (ZUP) for individual houses, leading to their replacement by more vulnerable households, thereby causing population segregation and increased vulnerability (Schuman 1987; Terrin 2008). Furthermore, primarily designed for the working class, the 'Grands ensembles' consist of government-subsidized rental housing and typically house households with low incomes, high unemployment rates, large families, single-parent households, limited educational attainment and immigrants.

The problems encountered in these housing estates encompass unsatisfactory living conditions, subpar construction quality, inadequate maintenance and lack of services. Additionally, this is coupled with other spatial issues, including oversized pedestrian pathways, poor use of public spaces and high population densities (Tuppen and Mingret 1986). These conditions have led to an environment marked by safety problems such as vandalism, crime and violence, resulting in an increasing feeling of insecurity among residents (Terrin 2008).

By the late 1970s, numerous efforts were underway to enhance the social and economic conditions within 'Grands ensembles' by creating job opportunities, providing social, educational, and cultural amenities, and involving revitalizing the built environment, and enhancing security measures (Tuppen and Mingret 1986).

The French government established the Agence Nationale de Renouvellement Urbain (ANRU), under the Borloo law in 2003. Based on the failure of previous policies deemed too social since the mid-1990, namely *Grand Projets de la Ville* (GPV), *Grand Projets Urbains* and *Banlieue 89* (Kipfer 2015; Schuman 1987). The ANRU launched the Programme National de la Renovation Urbaine (PNRU), which focused on urban transformation and urban renewal (Férial et al. 2010). The PNRU aimed to reconstruct social housing in target districts i.e., (ZUS), by promoting social mix and sustainable development. It involved demolishing, rehabilitating, and redesigning built forms, while diversifying the housing supply by including market-rent and ownership housing on the redeveloped sites (Terrin 2008). PNRU sought to address the issue of stigmatized housing by reducing subsidized residences and diversifying housing tenure. However, it did not significantly improve residents' economic conditions, social integration, or territorial social equity. Instead, it led to social fragmentation, fine-grained segregation, and varying patterns of residential mobility. The PRU and social mix policies of the 2003 reform are largely considered a failure (Kipfer 2015), with unintended consequences contributing to reinforcing segregation (McAvay and Verdugo 2021). This approach often encouraged those with financial resources to move, undermining income level diversity and increasing physical and social disorders within communities (Kipfer 2015).

Fear's perception

People's behaviour and mobility in cities are influenced by their perception of safety, which is strongly tied to the study of crime fear (Ceccato 2016). When people change their behaviour to avoid these fearful emotions, it is important to understand why (Doran and Burgess 2011). Perception of crime studies can be first associated with the socio-demographic and population characteristics, such as physical and psychological abilities and gender, age group, social and economic status (Ceccato 2020), and ethnicity (Glas, Engbersen, and Snel 2019). The second perspective, from an environmental design standpoint, emphasizes the role of physical and social features of the urban environment in generating fear of crime (Fisher and Nasar 1995). It is relevant to understand how urban planning and policies' measures, including permeable and accessible street configurations, mixed-use developments, and specific densities, can effectively reduce both the incidence of crime and the fear of crime in urban areas. The impact of permeability on security and crime prevention has been largely discussed through the 'encounter' model and 'enclosure' models (Cozens 2011). The encounter model, supported by the New Urbanism (Gehl 2001; Hillier and Shu 2000; Jacobs 1961), emphasizes that open, accessible and permeable neighbourhoods encourage pedestrian movement, social interactions, and informal guardianship, and improve safety. The 'enclosure model' derived from the defensible space theory (Newman 1972), argues that limited permeability and controlled access through privatization reduce crime opportunities, leading to the development of gated communities.

Mixed-use developments are widely recognized as preferable to strictly residential neighbourhoods due to the availability of services, amenities, and increased pedestrian movement (Jacobs 1961). This enhances safety and reduces crime. However, land-use diversity can influence routine activities and potentially raise the risk of specific crimes (Kitchen and Schneider 2007).

There is a lack of consensus on whether high or low densities are consistently beneficial to the built environment. Higher densities (Wheeler 2013) can be revealed as a more socially relevant form, potentially meaning more surveillance (Berghauser and Haupt 2009; Jacobs 1961), therefore lower crime rates, and increased security. Others consider that low density can also be a characteristic of a high-quality built environment (Brehny 1997) with fewer crime targets (Newman 1972). Kitchen and Shneider (2007) compared a dense permeable housing estate with a lower-density estate dominated by *cul-de-sacs*, and found that crime and public disorder were significantly higher for the higher-density permeable development. However, high-density housing does not necessarily imply high population densities. Living in high-density conditions 'crowding' is associated with various behavioural issues, and increased crime rates (Roncek 1975) than less-densely populated suburban areas (Cozens 2011). Space Syntax approaches suggest no direct association between crime and density or socioeconomic affluence (Hillier and Shu 2000). However, a strong correlation exists between traditional street patterns and lower crime rates (Hillier 2004). Overall, the three objectives of urban renewal programs, namely promoting permeability, mixed-use developments, and low densities, are not always socially advantageous.

GIS and fear of crime

Measuring safety at the scale of a neighbourhood and street is a complex task. Instead of being at fine-grained local sizes, most of the available data came from conventional sources at the metropolitan scale (Hawken et al. 2020). Fine-grained localized safety data is rare, and is often confidential, gender-biased (German et al. 2022), and also underestimates street crimes. Moreover, research on fear in public spaces has been primarily qualitative and non-spatial, and the evaluation of the fear of crime is a non-straightforward task (Doran and Burgess 2011). Addressing this challenge is indeed fundamental for urban planners, sociologists, economists, and policymakers (Hawken et al. 2020).

In recent decades, the field of Geographical Information Science with the emergence of the Internet Of Things technology (IoT) (German et al. 2022), positioning systems and observation sensors, crowdsourcing platforms (Pánek 2018), and real-time data (Chataway et al. 2017) offer many novel opportunities for observing environmental and urban systems over long periods of time. These developments have made data collection more accessible and empowered citizen participation. Geographical Information Science, when combined with Geospatial technology, helps urban planners in understanding people's interactions with their environment analysing their perceptions through the acquisition and manipulation of spatially explicit data. This enables location-based analytics and the identification of spatial patterns at complementary scales (Hawken et al. 2020). Previous research has addressed this issue by analysing variables across different contexts and scales, and testing variables across different land uses (Jakobi and Podör 2020). This could help planners design safer cities and design better references for the evaluation of humans' perceptions of a given urban environment.

Space syntax and fear of crime

Space syntax has long focused on crime and fear of crime as urban phenomena (Alford 1996; Hillier 2004; Van Nes and Yamu 2022). Space syntax analyzes the relationships between urban structures, functional patterns, behaviours, movement and social interactions (Hillier and Hanson 1984). An urban spatial layout is first represented and described as a system of linked geometrical elements: axial lines, convex elements, and visual fields (Hillier 2004). The interconnectedness of spaces determines different configurational spatial properties like accessibility, permeability, and visibility. The urban form generates different types of movement, including natural movement, to specific destinations called 'to-movement', along the shortest routes 'through movement' (Hillier et al. 1993). These movements are strongly correlated with syntactic variables such as respectively 'Integration' which measures the topological relative accessibility, and 'Betweenness centrality' (Freeman 1977; Hillier and Iida 2005) which measures the likelihood of movement along the shortest paths. Connectivity measures the number of immediate connections of a space, and indicates its importance in promoting relative accessibility in the system (Hillier and Hanson 1984). It has been shown that areas with higher syntactical accessibility attract more pedestrians and vehicles (Penn et al. 1998). Hillier (1988) suggests that a spatial configuration that makes natural pedestrians' movement difficult can impede natural surveillance and the perception of a well-appropriated space (Jacobs 1961). The way the

street network and the distribution of movement densities' distribution across the network influence the distribution of crime patterns (Alford 1996). Although Space Syntax is effective in measuring street-network properties (Hillier 1996); it does not consider other morphological aspects like frontage and built-mass density, as noted by Ratti (2004).

Case study

This study was conducted in La Reynerie and Bellefontaine, two housing estates within the 'Grand Mirail' district (Figure 1). The district is a part of urban renewal programs (PRU) and experiences ongoing issues of insecurity and fear of crime. The study area is located on the southwestern outskirts of Toulouse city, with a total surface area of 183 ha and 15,037 inhabitants (INSEE 2017). The area benefits from good accessibility within the city through arterial roads and subway stations.

Both neighbourhoods include approximately 5,015 housing units made up of high- rise buildings, bars and tripods of collective social housing and private condominiums, but also small collective and individual houses in the Bellefontaine neighbourhood. Both neighbourhoods are among the very poor and precarious districts; indeed, respectively, 30% and 50% of households lived below the threshold of poverty (INSEE 2017).

The Grand Mirail project, initially designed by Candilis' team in 1962 as a modernist new town, aimed to be the largest ZUP in France, covering 800 hectares and accommodating 100,000 residents with a target of 75% social housing. It sought to balance urban development in Toulouse's left bank. However, the project faced procedural challenges and funding disruptions (Bourret 2019), resulting in only the completion of the Bellefontaine neighbourhood in 1972, adhering to all principles of the development and featuring uniformity in housing types with less visible social differences. In contrast, La Reynerie lacks the same unity and exhibits more pronounced segregation (Jaillet-Roman and Zendjebil 2006). Le Mirail, like many ZUPs, experienced an exodus of middle-class residents to individual houses on the periphery, replaced by different social strata. Private housing also deteriorated, becoming a refuge for those rejected by social housing. The neighbourhood's image deteriorated in the 1980s, as it was portrayed in the media as a disadvantaged ghetto. By 1990, it met most criteria defining priority areas for urban policy, with a concentration of immigrant and low-income populations. It joined the *Politique de la ville* in the early 1980s and was designated ZUS by 1996. Le Mirail has faced various challenges, including economic hardship and social issues such as population replacement, unemployment, the built environment's decay, crime and insecurity. Various investments were made to improve the living environment, with the aim of attracting more diverse social groups than the current residents. Housing quality, green spaces, amenities, and increased accessibility due to the metro opening in 1993 were expected to overcome stigmatization (Jaillet-Roman and Zendjebil 2006).

Since 2004, the Grand Mirail has been through several renewal programmes (Jaillet-Roman and Zendjebil 2006) involving demolition, public space redevelopment, rehabilitation, *residentialisation*, and mixed-housing programmes (Figure 2). The objectives of PRU include creating open and accessible neighbourhoods with improved visibility, secured mobility, and a new axis linking Bellefontaine to Reynerie and Mirail University. The objectives of the PRU are pursued with the main goal of carrying out a deep mutation of both neighbourhoods by 2040, involving the demolition of large housing estates and

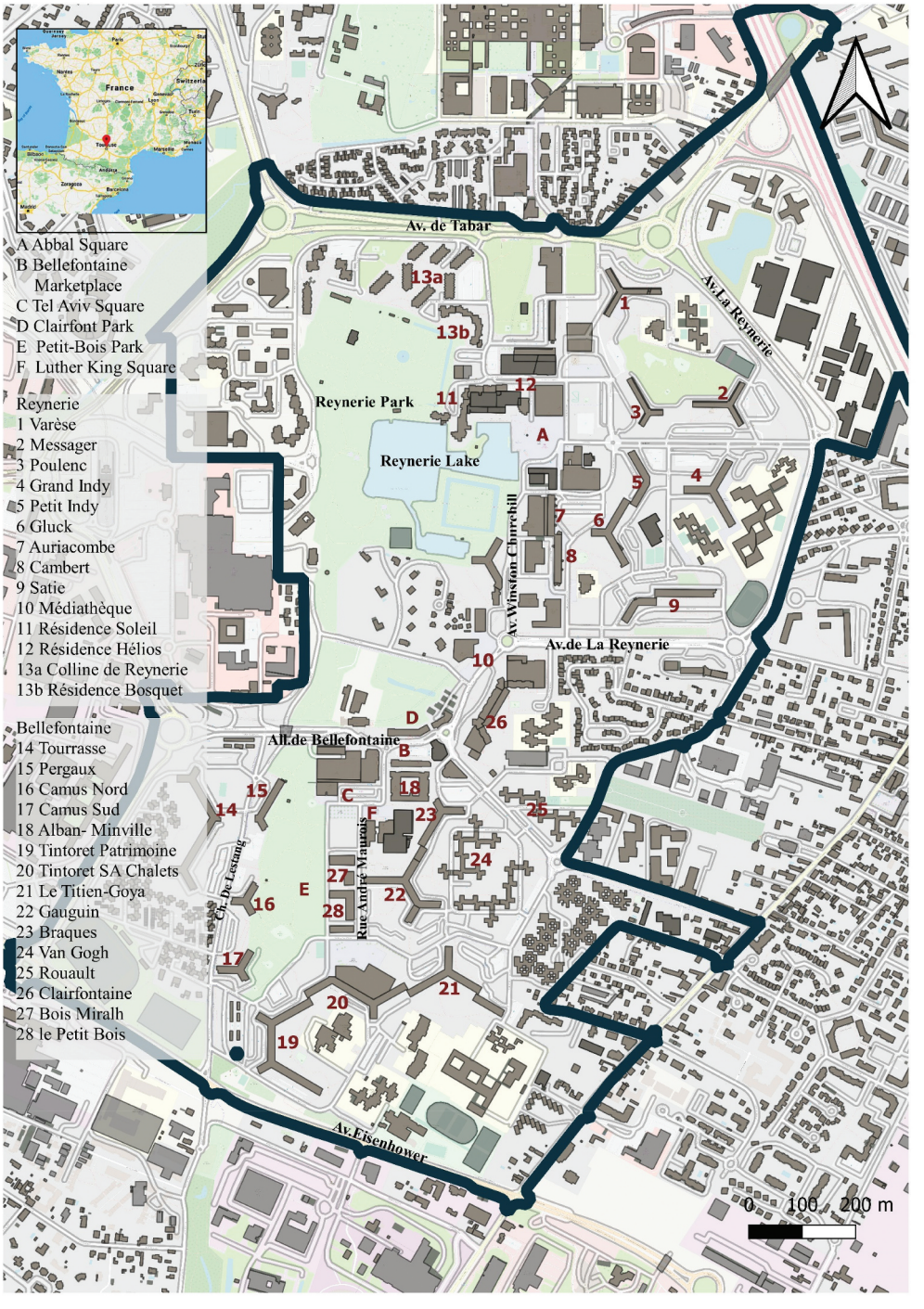

Figure 1. Study area: the two housing estates of Reynerie and Bellefontaine (Source: authors).

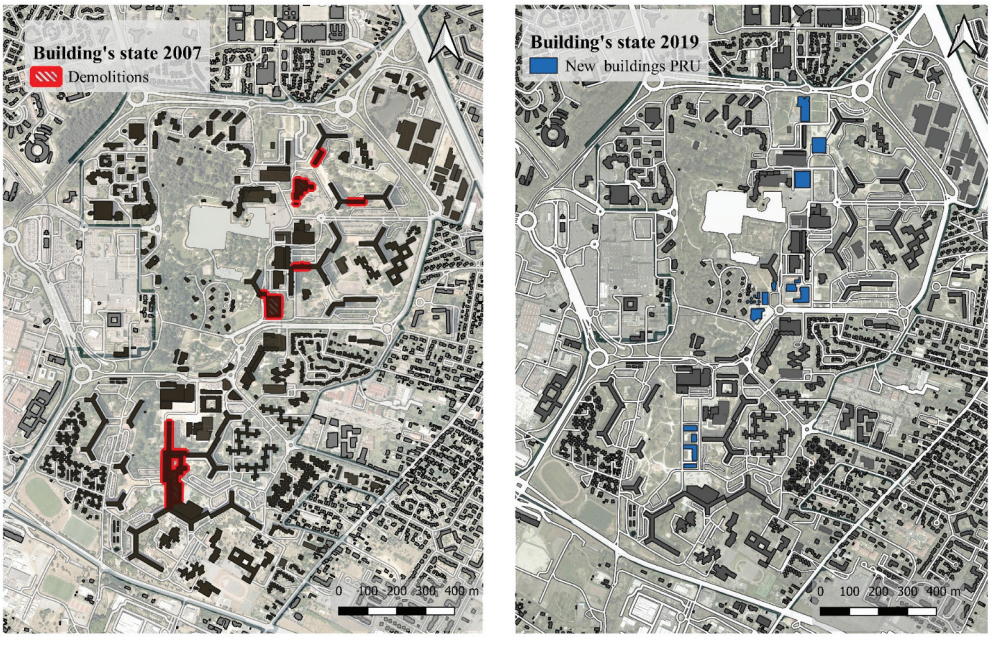

Figure 2. Building's state before (left) and after (right) PRU. (Source: authors).

the construction of new smaller, less dense collective housing units with more attractive architecture and enhanced public amenities.

Methodology

The methodology is grounded in a GIS framework (QGIS 2018) to integrate and visualize the different data collection and space syntax measures, including quantitative morphological and spatial analysis (Van Nes and Yamu 2022). The study is performed in three steps (Figure 3); (i) data collection; (ii) selection of independent variables related to perceived security; (iii) exploratory and statistical analysis.

According to PRU, improving security in priority neighbourhoods requires three key factors: improving street network accessibility and visibility, and reducing density and social mix. The study examines how these variables influence the classification of the space as safe or unsafe. The selected independent variables include spatial characteristics, morphological configurational variables from space syntax methodology, density, and social neighbourhood properties.

The Visual Graph Analysis (VGA) (Turner 2004) was applied to represent the urban forms. In modern and large housing estates, streets have unclear boundaries compared to historic neighbourhoods, and open spaces are less defined. VGA depicts the visual and intervisibility connections of urban open spaces and identifies areas with increased or decreased visibility. The VGA can identify the visibility of strategic entry points and hidden corners, which are attractive locations for criminal activities. In open and less-defined outdoor spaces, a more significant correlation is found between VGA visibility and pedestrian movement than between other space syntax analysis techniques (Desyllas

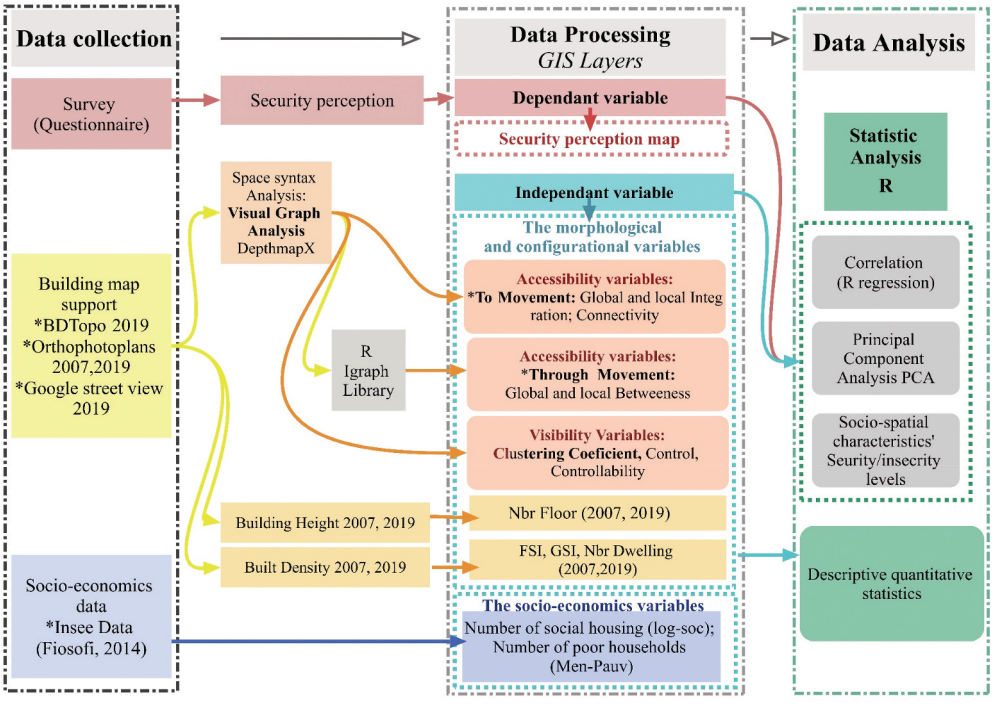

Figure 3. Research framework. (Source: authors).

and Duxbury 2001). The VGA was implemented for the two relevant periods (2007, 2019) based on map support of the building and the existing obstacles on site (e.g., vegetation); integrated from the reference geographical dataset BD-TOPO-2-0 and the orthophoto plans for the two periods. Once the support is established, it was exported to the open-source software Depthmap X©, to perform a VGA. The morphological configurational variables output from VGA included two categories of space syntax variables, namely:

Accessibility

Including the two sorts of movement through Global and Local Integration and Connectivity for to-movement and Betweenness (Freeman 1977) for the through movement. However, as DepthmapX© does not provide the measure of Betweenness, the latter was calculated using the program R version 3.6.3 (R Core Team 2020) by importing VGA connections from DepthmapX© version 0.80 (DepthmapX Development Team 2020), with the Igraph library version 1.3.5 (Csardi and Nepusz 2006).

Visibility

While accessibility is about 'where you can go' visibility defines 'what you can see' through the three local measures of Control (Hillier and Hanson 1984), Controllability (Laouar, Mazouz, and Teller 2019; Turner 2004) and Clustering Coefficient (Turner et al. 2001). Visual Control defines whether the space visible from a location in relation to other

directly visible locations is more than what they see or less, whereas the Controllability measure denotes the ratio between the number of visible immediate neighbours and the sum of all locations visible from these immediate neighbours. The Clustering Coefficient gives the degree of visual concentration of a given location, how these clusters vary throughout the represented system, and how a pedestrian's space perception changes when distant from a given location (Hacar, Öztürk, and Bilgi 2020).

Density

Four variables were included: Floor Space Index (FSI) (amount of built floor area to a plan area), compactness or coverage (GSI) (built (footprint) to non-built space), and building height (nbr-floor), number of dwellings (nbr-dwelling). Ground area of a building, number of floors, and surface area's floor are reported for both neighbourhoods for the periods 2007 and 2019. The data was collected from the national topographic database and Google Street Map. The cell grid raster size was defined at a granularity of 100 m × 100 m so each grid must cover a part of the urban space as well as buildings.

Socio-economic data

For both neighbourhoods, the variables used are a specific number of social housing units (Log-soc) and poor household rates (Men-pauv). A 'Localized Social and Fiscal File' (Filosofi 2015) has been used as gridded data (200 m × 200 m) and associated to socio-economic and demographic characteristics.

Dependent variables: security perception

Data on people's perceptions of PRU and security was collected through a face-to-face questionnaire and sketch maps. The survey targeted residents, former residents, members of these neighbourhoods' associations, shopkeepers, and frequent users before and after the PRU. The initial sample size was 300 individuals, with 100 responses analysed due to non-responses and partial responses. Many participants expressed their fear about sharing sensitive safety-related information. The final sample was matched as closely as possible to the population; with 59% women and a majority between the ages of 20–60 years. The survey covered topics such as perception of security before and after PRU, impact on behaviour, and experiences of crime or offence before and after PRU. The contents of the questions included in the questionnaire are summarized in the Table 1.

A base map of both neighbourhoods was provided for two periods in 2007 and 2019, with instructions for colour-coding security perception. Residents were asked to draw polygons for areas that they considered safe (Green) or unsafe (red). They were also required to provide detailed explanations for feeling unsafe in those areas. Residents who were surveyed provided no sketch maps regarding the 2007 period, stating that they no longer remembered that time due to ongoing changes and that they encountered difficulties in identifying and locating the safe and unsafe spaces on the old map. To address this data gap, information from the questionnaire was used to compare the evolution of security state for the two periods. Consequently, only the sketch map for 2019 was usable and was retained for the analysis. The obtained sketch maps were digitalized and aggregated

Table 1. The topics addressed in the questionnaire.

Objective of the survey -questionnaire	
	• Gathering data from residents about their subjective and objective perceptions and conceptions of security.
01	**Impact of Urban Renewal program (PRU)**
	• Evaluating the impact of PRU on the organization of the neighbourhood including aspects like street lighting, cleanliness, parking lots, walking paths, urban furniture, and green spaces; its effects on security; and the changes in perceptions before and after the programme.
02	**Influence on Resident Behaviour**
	• Investigating how residents' feelings of insecurity affect their behaviour, including changes in public spaces usage, attendance, duration, avoidance, and vehicle parking before and after PRU.
03	**Experiences as crime victim before and after PRU**
	• Collecting data on residents' experiences as victims or witnesses of crimes, including their nature, frequency, location, and timing, both before and after urban renewal operations.

Source: authors.

towards a 25 m × 25 m grid. Each grid cell was assigned values based on the number of occurrences of safe (safe count) or unsafe locations (unsafe count). By subtracting the values of safe and unsafe areas ('safe count'–'unsafe count') the map of security is generated. The grid data obtained was used as the dependent variable in relation to other independent variables for the same period in 2019.

The statistical analysis was performed on the R platform version 3.6.3 (R Core Team 2020). The data were aggregated based on 100 m × 100 m grid, which aligns with the density grid. Different variables were calculated within each grid, including sum, mean, standard deviation, minimum and maximum values of the corresponding base units. Georeferenced data were aggregated with the results of VGA space syntax analysis (Figure 4). Correlations and regression coefficients (R^2) were analysed to examine the relationships between the perceptions of security and insecurity (Safe count, Unsafe Count) as dependent variables and other variables as independent ones.

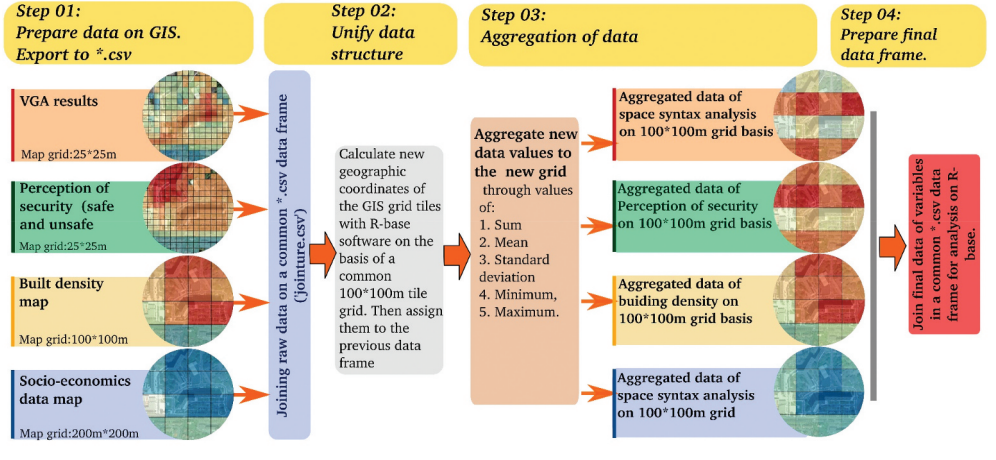

Figure 4. Aggregating georeferenced data in R. (Source: authors).

Results

Perception of security by inhabitants regarding the PRU program

The street interview aimed to assess resident's perceptions of safety before and after the urban renewal program (PRU). Results showed that 42% of surveyed residents observed no improvement in security and felt even more insecure after PRU. On the other hand, 27% of interviewees perceived stability, while 31% noted a clear improvement and appreciated openness and visibility in the neighbourhood due to urban developments under PRU. However, most interviewees expressed dissatisfaction regarding the lack of citizen consultation during the PRU process. The interviewees indicated an important resident opposition to the programme and condemned the housing and security authority for being insensitive to their concerns. Regarding public space uses, 67% of interviewees frequented the public space rarely or briefly for daily routine movements, and 53% did not go out at night due to fear of violence. Moreover, 57% avoided parking their cars in the neighbourhoods' car parks due to recurrent vandalism, theft and vehicle fires.

The survey findings show that nearly 60% of residents found their neighbourhood worrying and highly hazardous, while 40% felt safe. This trend persists across different age groups and genders, regardless of their familiarity with the neighbourhood before the PRU. Interestingly, although 60% of respondents have never experienced any form of violence after the PRU, nearly half of them (28%) still consider their neighbourhood unsafe. This trend is also observed among 74% of participants who had never been victimized before the PRU; however, 39% feel unsafe in their neighbourhoods either. Regarding gender differences, among the 59 women interviewed, 30% had experienced violence before the PRU, increasing to 40% after PRU. For the 41 men questioned, 19% were subject to violence before the PRU, against 39% after the PRU. As predicted, the interviewees reported a higher rate of violence after the PRU program, aligning with recent police statistics. Drug trafficking was identified as the primary cause of violence, followed by road traffic safety issues and the increasingly common practice of Rodeo. Vandalism particularly targeting private property such as fires in cellars, garbage cans, and parked cars were prevalent in these neighbourhoods. Violent crimes against the person and property crimes were also reported. Interestingly, these findings contrast with police reports, which rank drug trafficking as lower priority. Nearly 90% of respondents expressed dissatisfaction with their neighbourhoods and law enforcement actions, citing fear of crime, particularly drug trafficking and its related underground economy, as major concern.

Spatial configuration before and after the urban renewal program

The new developments of PRU have shown significant improvements in the accessibility and permeability of both neighbourhoods, as indicated in Table 2 and Figure 5.

The values of Mean, Min and Max values, the Connectivity and Visual Global Integration HH, Local Integration R3 are increased, which could potentially enhance the rate of the to-movement in the neighbourhoods. However, Global Betweenness appears to decrease after PRU, which consequently may decrease the rate of the through movement in the neighbourhoods. The PRU primarily affects the global properties of the spatial configuration

Table 2. Descriptive statistics of spatial variables from VGA (Depthmap X©), (Source: authors).

			Min	Median	Mean	Max
Accessibility To-movement	Global Integration	2007	1.021271	1.824383	1.861581	2.872845
		2019	1.172365	2.372281	2.361607	3.607482
	Local Integration	2007	1.737312	5.062727	5.2476	8.615199
		2019	1.958589	5.599066	5.516627	7.688093
	Connectivity	2007	3	89	153.7742	906
		2019	3	137	193.1283	922
Accessibility Through-movement	Global Betweenness	2007	0.020408	4088.394	38848.31	5287967
		2019	0.015164	4421.011	33417.19	6831810
	Local Betweenness	2007	0.020408	365.7698	1093.952	81910.12
		2019	0.015164	673.4325	2025.308	122611.8
Visibility	Clustering coefficient	2007	0.1	0.62511	0.631853	0.998558
		2019	0.166667	0.59126	0.604776	0.998558
	Control	2007	0.034698	1.020484	1.012611	2.394473
		2019	0.035132	1.016843	1.010144	2.300598
	Controllability	2007	0.013158	0.189024	0.22775	0.772152
		2019	0.004896	0.162626	0.197809	0.759036

rather than the local ones. Regarding visibility, the Control values remain unchanged, but certain local visibility properties, such as the Clustering Coefficient and the Controllability, exhibit lower values, denoting a trend towards openness in many neighbourhoods.

Figure 6 shows the Visual Integration values HH from the VGA conducted using (Depthmap X©) for the two periods (2007, 2019) before and after the PRU. Red-coloured areas indicate highly accessible spaces with strong visual integration, while blue-coloured areas represent more segregated and less accessible areas. The 'Integration core' is highlighted by a red-orange, particularly evident after PRU, notably due to the prevalence of the axis section connecting Abbal Square to the Bellefontaine marketplace and Chemin de Lestang. This promotes Bellefontaine's opening to main city axis, namely Eisenhower by the South. Visual accessibility has significantly enhanced in both neighbourhoods, through demolition, reduction of vegetation, and development of a new pedestrian path in the west of Bellefontaine (Petit Bois), enhancing pedestrian to-movement in that area.

The spatiality of security perception

Figure 7 displays areas pointed out by respondents as safe and unsafe.

- Safe and quiet areas overlap individual housing, low-rise condominiums, locations near parks (Chateau de la Reynerie, Petit Bois, Clairefontaine), and the marketplace of Bellefontaine and Jerusalem Square.
- Insecure areas primarily consist of problematic housing sectors, specifically the tripods and bars, in both neighbourhoods. The core of fear lies in the heart of the Reynerie district in the encompassing sector (Gluck, Auriacombe-Cambert), the northern shores of Reynerie Lake. At Abbal Square, residents also experience a lack of security.

Unsafe areas overlap the high concentration of social housing, sheltering many low-income households, mostly located at the Reynerie (Gluck Auriacombe-Cambert) and in Bellefontaine (Tintoret Patrimoine). Neutral or moderately safe areas tend to localize at a relatively lower poverty rate among their population.

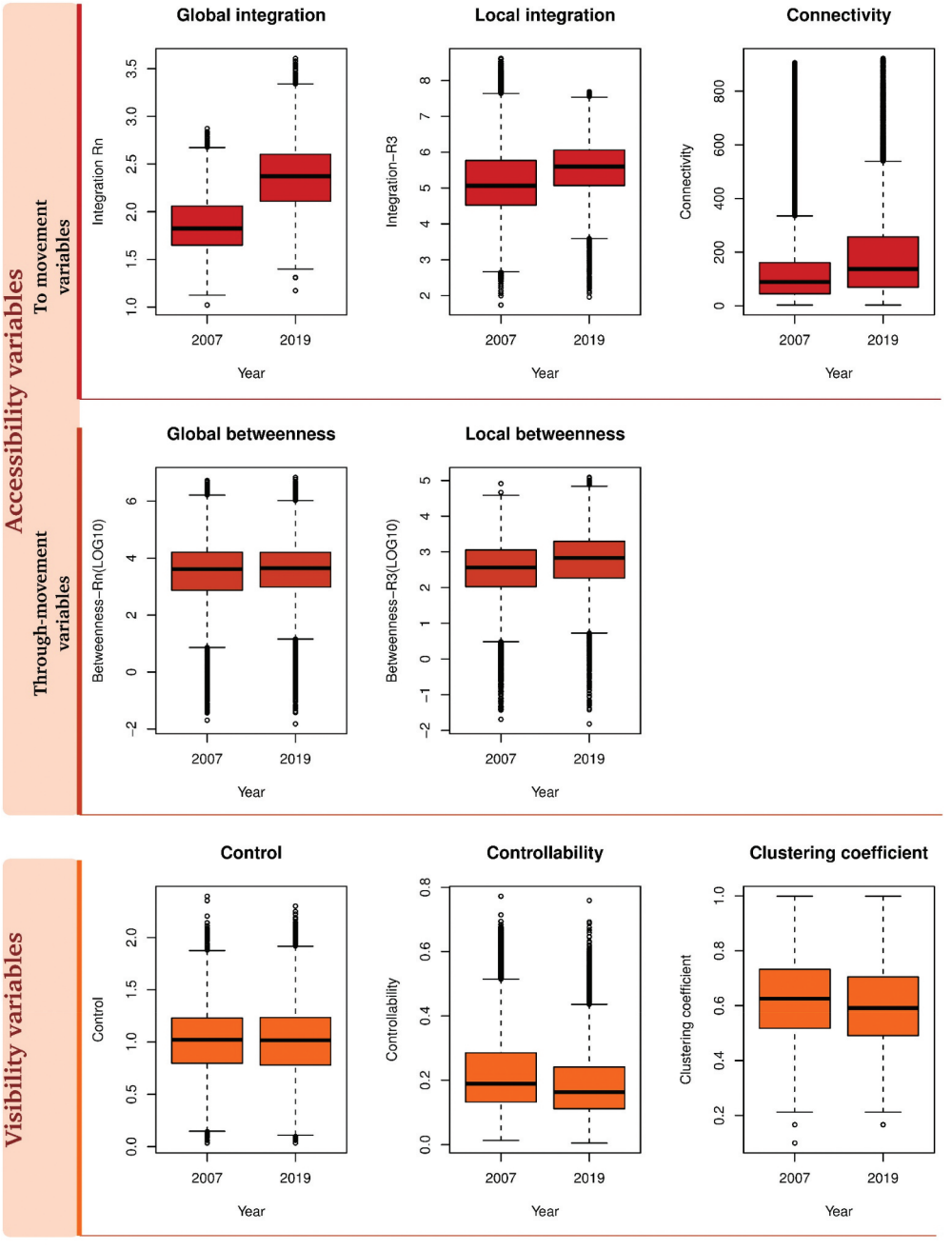

Figure 5. Descriptive statistics of spatial variables from VGA (Depthmap X©) before (2007) and after PRU (2019), (Source: authors).

The predominant factor contributing to fear and insecurity perceptions among residents is essentially drug trafficking. Indeed, observed locations of drug-dealing lookout activity perfectly overlap the identified unsafe areas (Figure 7).

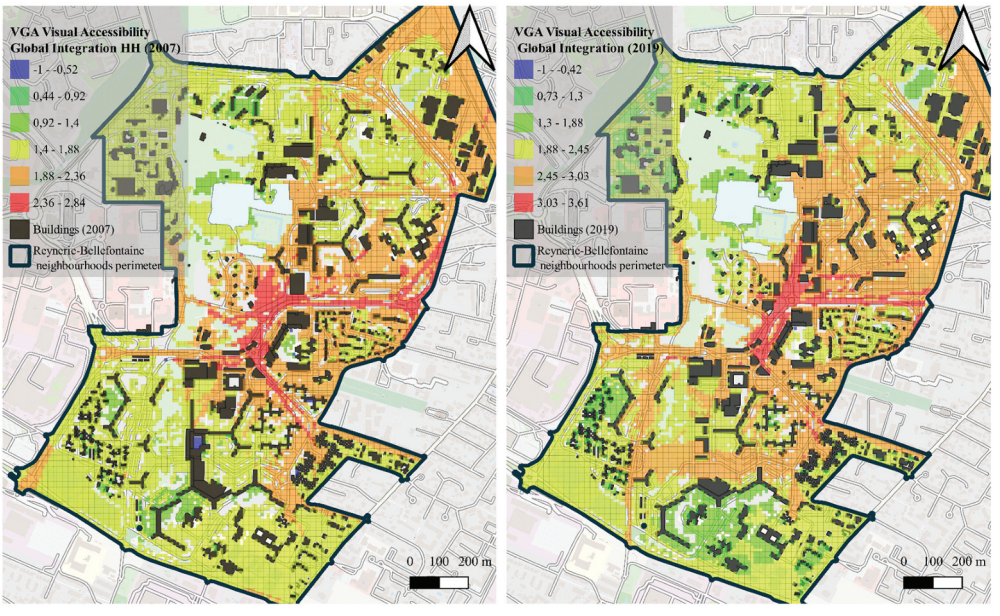

Figure 6. Visual accessibility before 2007 (left) and after 2019 (right) urban renewal operations (VGA: Visual Integration HH) from space syntax modeling (Depthmax X©). Analysis support: BD-TOPO 2.0 updated according to orthophoto-plans 2007, 2019 (Source: authors).

Figure 8 presents the different scatter plots and regression coefficients, revealing positive correlations for both the perception of security (safe count) and insecurity (unsafe count).

Moreover, only the sum of VGA's variables shows significant correlation, which seems logical since cumulative values are more accurate for this kind of localized data.

- The VGA measures related to both local and global accessibility as the sum of Global and Local Integration and local visibility values as the sum of Control, Controllability, and Clustering Coefficient are strongly correlated with insecurity perceptions rather than security perceptions. Additionally, the values of the sum of Connectivity and Betweenness Rn, R3 exhibit a moderate correlation with unsafe locations while showing a weak correlation with safe areas.
- On the other hand, the (mean) of socioeconomic disadvantaged variables, including social housing units, and the number of poor households exclusively correlate with insecurity perceptions. However, the R^2 coefficients indicate average correlations at 0.42 and 0.33 respectively.

The density variables, including the (mean) of both the Floor Space Index (FSI) and the number of dwellings (nbr.dwelling) exhibit positive and exclusive correlation with the insecurity perceptions (unsafe- count). However, the regression coefficients for these variables are relatively moderate (0.38–0.37), while building height (nbr-Floor) and compactness (GSI) show weak correlations (0.28, 024) respectively.

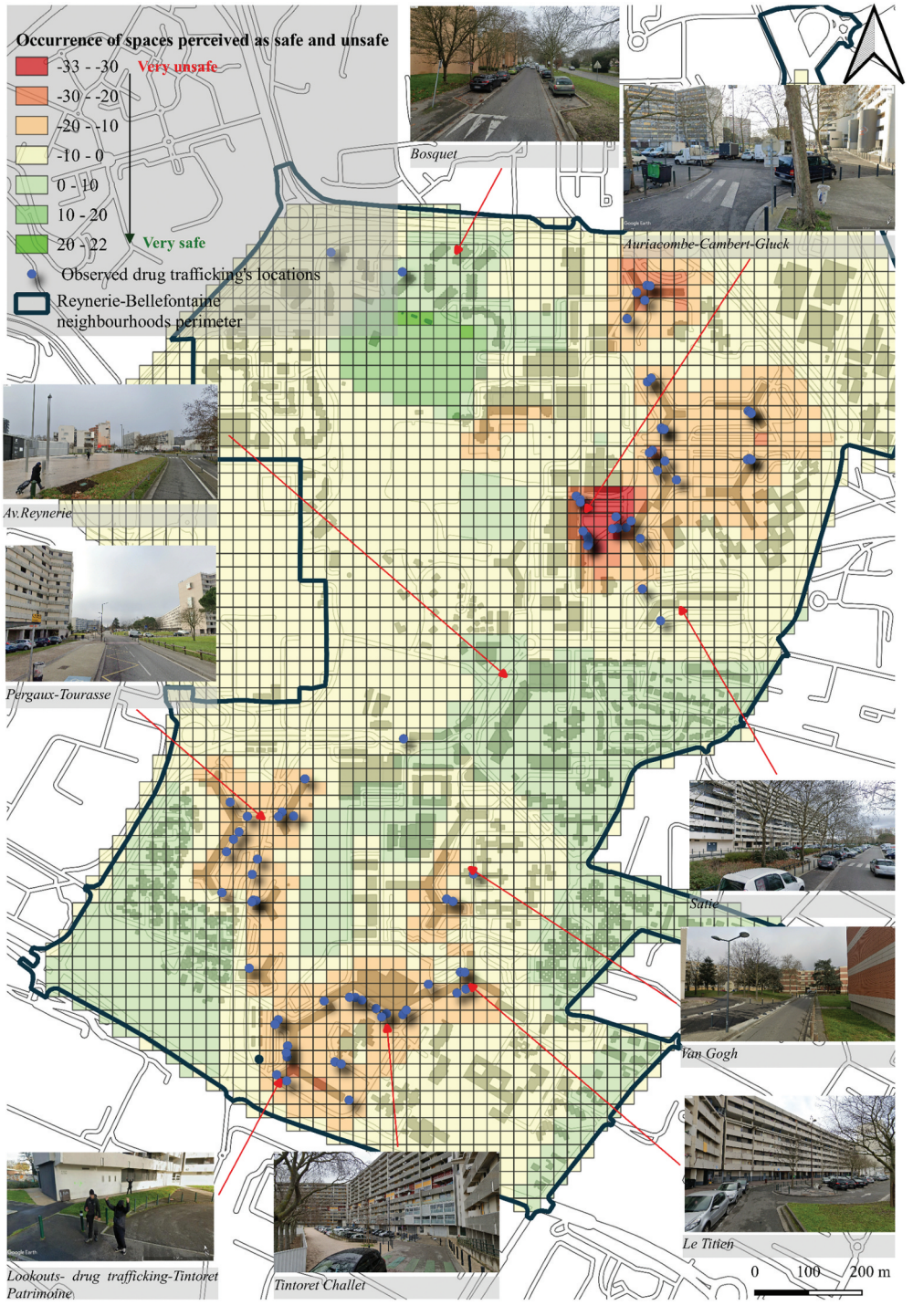

Figure 7. The occurrence of areas indicated by the interviewees as insecure (-) and secure (+), within the Reynerie and Bellefontaine districts; (Source: authors); photos: (Google Street View 2022).

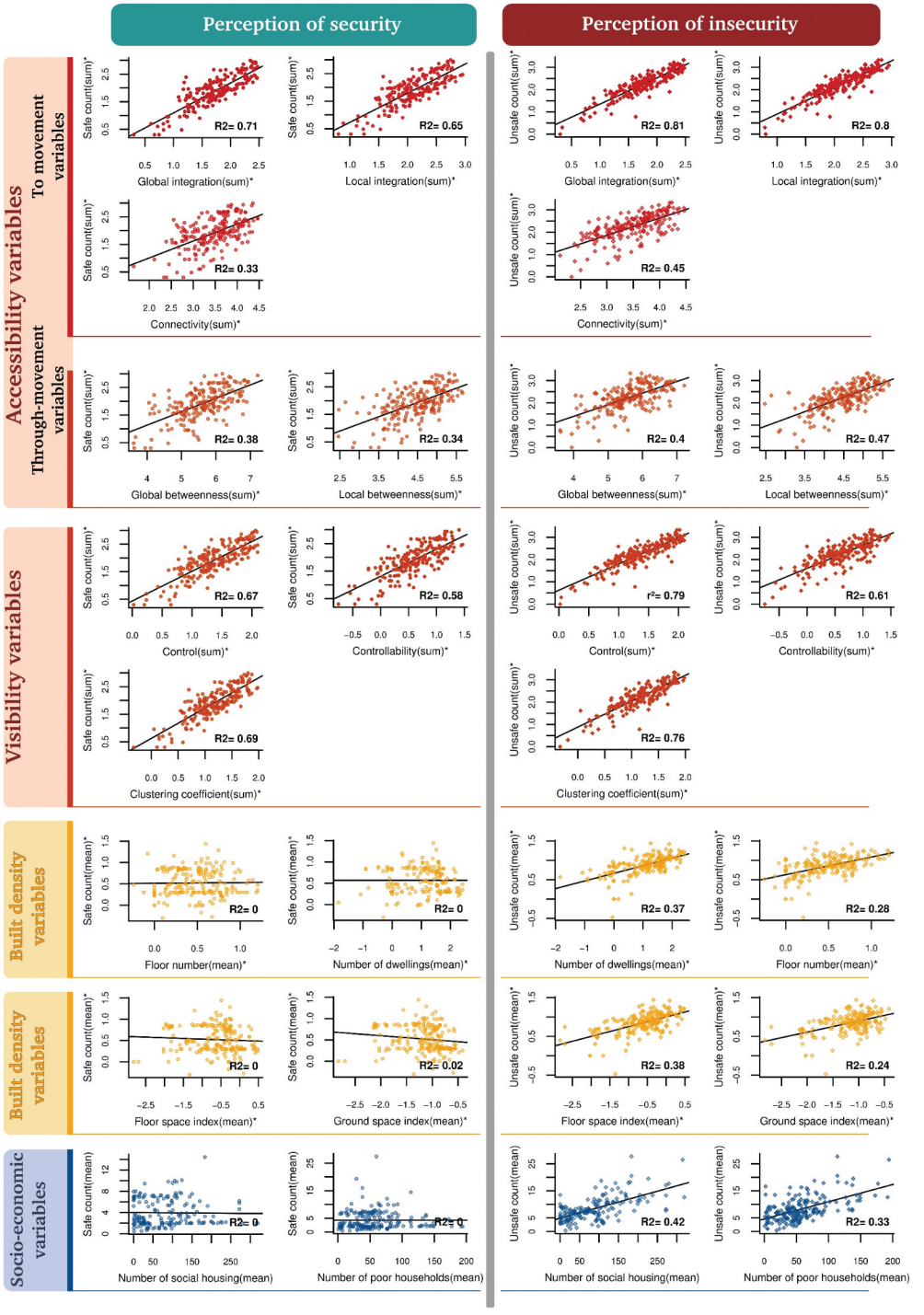

Figure 8. Scatterplot and regression coefficients of insecurity perceptions and security perceptions and the other morphological and configurational variables, density, and socioeconomics disadvantaged variables (Source: authors). *The values of independent variables are transformed using natural logarithms. It is observed that applying the Log10 transformation to the several variables generally leads to improved correlations except for the socioeconomic data.

A principal component analysis (PCA) was conducted using the R FactoMineR package version 2.3 (Lê, Josse, and Husson 2008) to support the analysis. Only the data from the table of (sums) and the (mean) data were retained. Figure 9 shows the dominance of a single principal component in the PCA, occupying 47.3% of the variance, surpassing the other components. This principal component includes the spatial characteristics related to VGA, specifically the accessibility, visibility and security variables. The main component of dimension (01) includes the following variables and their correlations: global integration 0.96, local variables as local integration R3 0.97, control 0.97, Cluster coefficient 0.94, and connectivity 0.81. The perception of insecurity (unsafe count) 0.87 is more strongly associated with this main component compared to the perception of security (safe count) 0.70. A second dimension, less representative, accounts for 22.39% of the variance and is composed of several variables with the following correlation coefficients: urban density indicators such as Floor Space Index (FSI) 0.87, number of dwellings 0.82, building height 0.78 and compactness (GSI) 0.70. Weaker correlations are observed with the socioeconomic disadvantaged factors such as social housing 0.59 and the poverty rate 0.56. These findings confirm the importance of specific independent variables identified in the scatterplots.

The next step in the analysis focuses on understanding the socio-spatial characteristics associated with different levels of security and insecurity perceptions. The data was sorted based on security level class and divided into quartiles: (0–25%, 25%–50%, 50%–75%, 75%–100%) for both safe count and unsafe count variables. Independent variables were

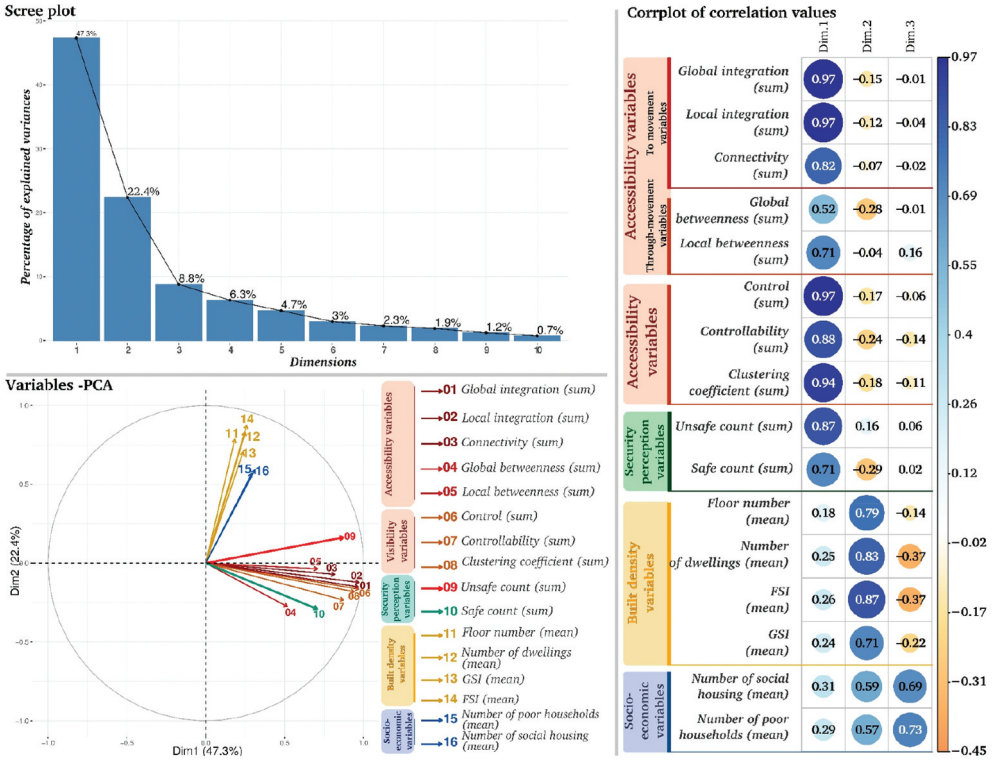

Figure 9. Principal component analysis results including morphological and configurational variables (accessibility, visibility), density and socioeconomic disadvantaged variables (Source: authors).

then associated with these security level classes using sums (for VGA variables) and means (for socio-economics and density variables).

Figure 10 reveals two remarkable findings that confirm the scatterplots and PCA's results. Safest locations (>75% of the safe count) exhibit lower configurational values in terms of accessibility and visibility compared to lower levels of security perception, displaying a decreasing trend in most spatial configuration parameters. Conversely, the perception of insecurity shows a relatively steady trend; however, locations in the second

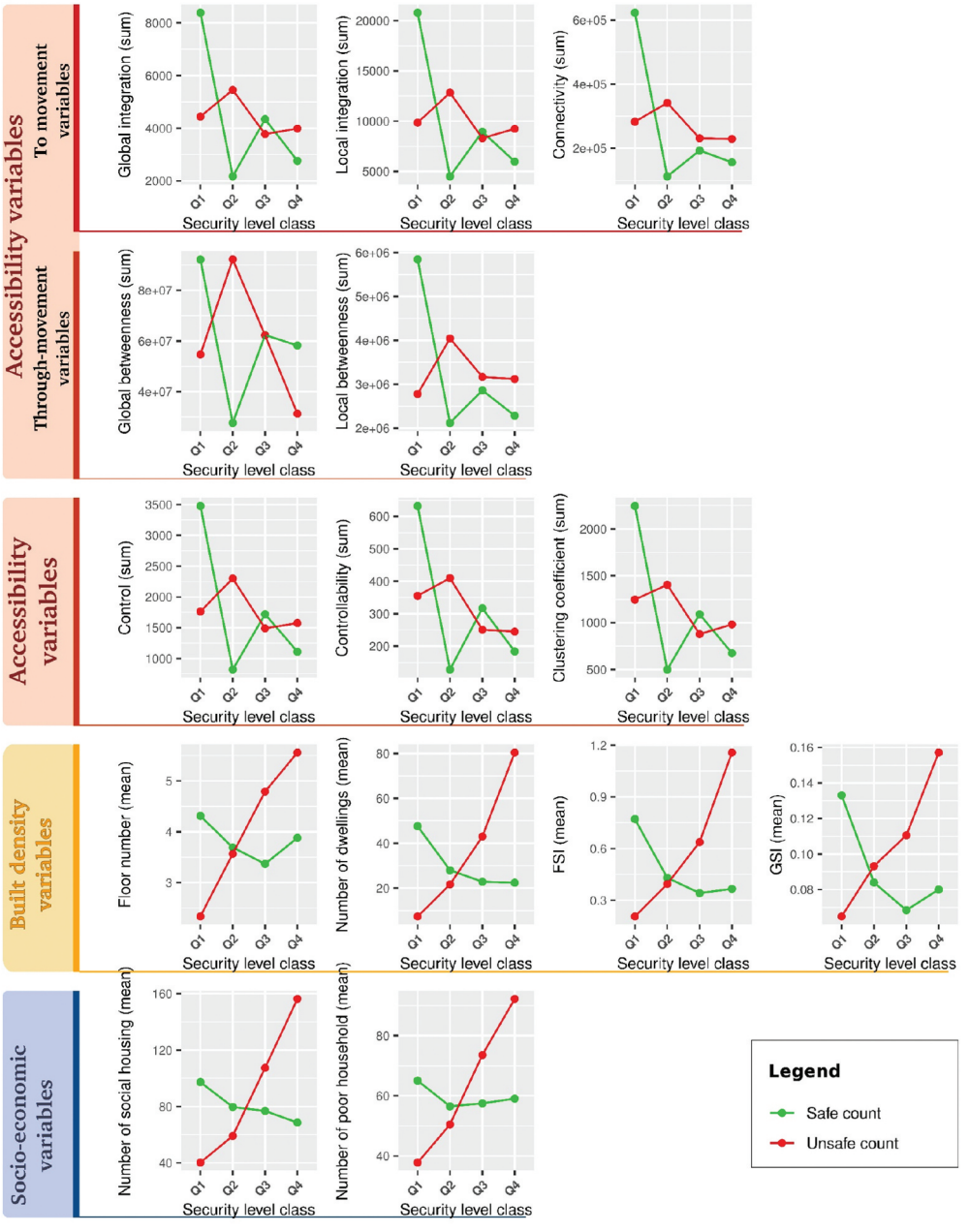

Figure 10. Socio-spatial characteristics of locations perceived as secure or unsecure (Source: authors).

level of insecurity (between 25% and 50%) have the highest values of accessibility and visibility. Figure 10 illustrates a clear trend in the four variables and levels of security and insecurity. Increasing rates of social housing, poor population, and building density (FSI) are associated with a sharp rise in insecurity levels. Conversely, as the density of social housing and the density of buildings (FSI) increase, the perception of security slightly decreases.

These findings highlight the significant influence of spatial characteristics, such as accessibility and visibility, on the perception of insecurity. Moreover, disadvantaged socioeconomic conditions, including social housing rates, poverty population, and building density, also appear to impact resident's perceptions of insecurity.

Discussion

Many indicators (Section 1) reinforce the earlier findings regarding insecurity. Public space uses indicators shed light on residents' perceptions of insecurity and its impact on their habits and behaviour. Fear of violence weighs considerably on the dwellers' daily routine. The feeling of insecurity and fear among the inhabitants do not stem from their personal victimization experiences. Nevertheless, the research shows an increase in victimization rates after PRU (Section 1).

Spatial configuration as location's choice generator factor of drug dealing

The new developments in PRU had a greater impact on the overall spatial configuration than the local ones. The accessibility and Connectivity of both neighbourhoods have been significantly improved (Figure 6). While certain structural properties, such as Control remain unaffected, others, like Cluster Coefficient and controllability, are inversely impacted, predicting increased openness in buildings' clusters. Despite attempts to enhance visibility and control in the districts, the results of PRU have led to globally accessible, well-connected spaces that are controlled but less controllable, so less dominated visually. These configurations have been found to be conducive to drug dealing (Figure 8).

The analysis reveals a significant and paradoxical relationship between spatial configuration and both perceptions of insecurity and, to a lesser extent, security (Figure 8). Permeable and visually accessible spaces can be considered safe (Jacobs 1961) but they are also targeted by offenders as the best crime locations, aligning with rational choice theory (Cornish and Clarke 2002). The street network configuration, particularly the level of accessibility, i.e., permeability, and visibility, is positively associated with fear perception and indirectly linked to drug dealing (Figure 8). Areas characterized by fear overlap with concentrations of drug trafficking and the observed lockouts in both neighbourhoods (Figure 7). These specific locations are determined by spatial and social configurations, indicating a non-random distribution depending on the spatial configuration and people's movements (Figures 8 and 10).

The analysis confirms that the insecurity level is more sensitive to the local spatial configuration than the global configuration. Parameters such as visibility (Control and Clustering Coefficient) and local accessibility (Integration-R3, Local Betweenness-R3)

appear consistently related to insecurity (Figure 8), emphasizing the requirement of local urban space developments to enhance security.

The PCA findings (Figure 9) highlight that the main component of insecurity's perception involves spaces that are well integrated globally and locally, accessible and frequented by residents and outsiders. These spaces are controlled, with a wide visual field, allowing observation of people's activities. Variables related to Local Integration R3 and to a lesser extent, Local Betweenness R3 ensure good local accessibility and pedestrian movement for both to-and through movement, while Connectivity indicates frequent crossing as these spaces serve as the shortest paths.

The findings (Figure 10) partially support the theory of rational choice, which suggests that people's decisions are based on assessing risks and consequences. The theory highlights three main conditions for crime: an available target, a motivated offender, and a lack of guardianship. Drug dealers do not randomly select their location but rather take rational decisions considering profitability and safety (Eck 1995; Rengert, Ratcliffe, and Chakravorty 2005).

The urban renewal program aims to increase spatial and visual accessibility in certain neighbourhoods (Figure 6). However, this unintentionally benefits offenders who seek profitable locations to enhance their markets, such as drug dealers looking for locations where many potential drug buyers can be encountered (Figures 8 and 10). Accessibility to potential customers is one of the key factors of successful retail (Eck 1994). Therefore, these offenders prefer accessible and permeable locations that are routinely frequented by non-residents (Eck 1994), as well as more controlled and uncontrollable spaces locally, which allow them to control their potential customers and be uncontrolled by the authorities.

Drug market placement is influenced by rational decision-making (Eck 1995; Rengert, Ratcliffe, and Chakravorty 2005) and exhibits similarities to legitimate markets (Eck 1995). Retailers prioritize accessible locations (Figure 8) to attract customers; drug dealers may adopt a similar strategy seeking profitable areas with good retail potential (Rengert, Ratcliffe, and Chakravorty 2005). However, illegal markets add a supplementary objective: ensuring safety and evading authorities to avoid arrest.

This confirms Tarkhanyan's findings (2015), which suggest that the urban fabric, particularly street network configuration, and land uses' distribution greatly affect drug occurrences (Eck 1994). The study showed that permeability and proximity to long streets increase the likelihood of drug crime. Not only does the facility itself attract crime, but the facility's specific configurational positioning on the street network also influences the likelihood of drug deals. This is evident in the new developments proposed in the Satie building (Figure 1), where the straight lanes facilitate drive-through deals and contribute to the emergence of new forms of delinquency, such as 'rodeos' on straight routes' slower flows.

Concentration of underprivileged populations in large densities as catalyst factors

The study findings indicate that the concentration of social housing and low-income residents in densely populated areas, measured by variables like Floor Space Index FSI and the number of dwellings, has a secondary effect on people's perception of insecurity and no impact on their feeling of security (Figure 8).

Furthermore, the prevalence of social housing, and vulnerable populations (Figure 10), also seems to influence resident's perception of insecurity, which arises from the presence of drug dealing in these areas. Drug dealers exploit disadvantaged areas to settle their traffic thereby easily hiring vulnerable families as 'drug minders and lookouts' and ensuring their silence to hide narcotics and firearms. In fact, as per social landlords, complaints to police services are minimal, as drug trafficking is commonly located in or near socially disorganized neighbourhoods, with a lack of social resistance to its presence and a ready supply of customers (McCord and Ratcliffe 2007; Rengert, Ratcliffe, and Chakravorty 2005). Research suggests that high poverty and precariousness can reduce informal social control (see Pickett and Pearl 2001), resulting in increased crime and violence. This perspective is rooted in the 'Social Disorganisation Theory' of the Chicago School (Kawachi, Kennedy, and Wilkinson 1999). Disorganized communities are less effective at exerting informal social control to maintain public order, leading to crime and delinquency. In the context of drug dealing, these social conditions shape the neighbourhood's social organization and reputation, leading to fear of crime among residents.

To constrain drug dealing, legitimate and effective guardianship and informal social control in the neighbourhood are needed to discourage criminal opportunities (Eck 1994). However, regarding these neighbourhoods, residents fear reprisals or are involved indirectly in this activity, hindering their ability to oppose drug markets. Lack of social resistance provides optimal conditions for drug markets (McCord and Ratcliffe 2007) and influences crime occurrence (Cornish and Clarke 2002). Rather than creating safe and liveable neighbourhoods, defended by residents, fear of crime transforms them into vulnerable areas and defendable territories for drug dealers, making these neighbourhoods offensive territories for denizens (Cozens 2011)

Conclusion

This paper introduces a structural approach whose objective is to provide a computational framework that favours the analysis of urban changes over time. It combines a qualitative evaluation of residents' perceptions of urban renewal programs, particularly in relation to security concerns, with a quantitative application of a series of spatial analyses based on space syntax complemented by socio-economic data. The whole provides an experimental framework that evaluates the impact of spatial configurations and urban improvements on security perception and facilitates a better understanding of how these perceptions influence residents' behaviours after renewal programs.

Finally, the finding suggests that areas with high accessibility and visibility, combined with the concentration of disadvantaged populations in dense areas are deemed to be more vulnerable and become prime locations for drug-related activities. Furthermore, the study found that building density has a secondary effect on the resident's sense of insecurity and has no impact on their feeling of security. Based on empirical findings, addressing crime and especially fear of crime in urban policy developments is crucial. Prioritizing physical development over community involvement can lead to more crime. Strategies such as community policing, enhanced effective surveillance, and social programmes for low-income residents can lessen the negative effects of urban renewal on crime.

Acknowledgments

The authors would like to sincerely thank the following individuals and organizations for their valuable contributions to this project: L. Gwiazdzinski, P. Fernandez, S. Faraut and M. Zendjebil (LRA ENSA Toulouse); A. Courtiade (TMH); J. Torres and F. Cavalho (Toulouse Metropole); C. Labdaoui and all the residents of Grand Mirail.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This project was carried out at LRA (ENSA-Toulouse) and was funded by the ATLAS short-term post-doctoral mobility program of the Arab Council for Social Sciences (ACSS) and the Fondation Maison des Sciences de l'Homme (FMSH).

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