Monitoring Land Use Change for Gentrification in Soho (London), Using Geographic Information Systems and Google Street View

Julia Desiree Velastegui, (MSc. in Geospatial Technologies)
Escuela Superior Politecnica de Chimborazo, Ecuador
Luis Alejandro Velastegui,
(MSc. in Seismic Engineering, Soil Dynamics and Structures)
Universidad Politecnica de Madrid, Spain
Manuel Fabián Moyon, (MSc. in Project Management)
Universidad de las Fuerzas Armadas-ESPE, Ecuador

Doi:10.19044/esj.2019.v15n17p1 URL:http://dx.doi.org/10.19044/esj.2019.v15n17p1

Abstract

Gentrification involves the substantial replacement of a neighborhood's lower-income residents with newcomers of higher income who renovate and upgrade the neighborhood. Although gentrification is first and foremost a residential process, it also entails commercial redevelopment. As the socioeconomic composition of the neighborhood changes, so it does the perception of acceptable land uses. In Soho, displacement has affect residents and local business in the same way, but the attention has been focused in the cultural and entertainment activities that have been currently disappearing, since once they were the heart of this neighborhood. The principal aim of this study is to develop a methodology to keep geographic land-use databases updated in order to analyze the spatial variability related with gentrification process of Soho. This study shows a methodology to keep geographic land-use database updated using Geographic Information Systems, through the use of panoramic photos captured by Google Street View. Since the panoramic photos from different years are now available, Google Street View could become a new tool to perceive, observe and study neighborhood changes in Soho during the years 2008, 2012, 2014 and 2015. Based on the obtained maps, there is a representative spatial variability that land uses show in Soho, as regardless the reduced extension of this area, the centroids are constantly moving from year to year. Therefore, Geographic Information Systems and Google Street View are useful tools to keep updated geodatabases; however, for future work it is recommended the inclusion of Volunteered Geographic Information.

Keywords: Geographic Information System, land use, gentrification, Google Street View

Introduction:

Gentrification can be defined as the reinvention of inner-city neighborhoods by the middle and upper classes. This process involves the substantial replacement of a neighborhood's lower-income residents with newcomers of higher income who renovate and upgrade the neighborhood (Glaeser *et al*., 2018). Gentrification can take several different forms: it can involve renovation of housing stock by middle class households in existing residential neighborhoods. It may involve private redevelopment of existing working class residential areas. The process can also involve the development of middle class housing in formerly non-residential areas. Finally, gentrification can be driven by different combinations of private market forces, public state intervention strategies, and nonprofit community development organizations (Zuk, 2018).

Considering the concept regarding gentrification, it has emerged as a major issue in urban and regional planning, particularly in the central cities of large metropolitan areas (Ghaffar, 2015). As more middle-class and upper-class residents begin to choose city life and reject suburban living, many older neighborhoods, once occupied exclusively by very-low income and low-income residents, are being re-inhabited by more affluent residents (Phillips, 2018). At this point, the problem is the lack of updated data related with this changes but not just like alphanumeric data but also as geospatial data which difficult the understanding of the spatial behavior related to gentrification. The Geographic Information Systems techniques have been a solution to identify land use change regardless the variable which causes the change (Olajuyigbe et al., 2015)

Regarding the limitations there have been few attempts to develop methods to create updated geographic databases that can support an effective model for monitoring gentrification, which would allow planners and policy-makers to be proactive in their approach to preventing many of the negative effects of this phenomenon (Goworowska,2008; Sivakumar, 2014). Moreover, the identification and monitoring of urban changes normally are aimed at recognizing land cover rather than land uses, which means, on the one hand, that they attempt to describe the Earth's surface with minimal reference to social purpose, referring to vegetation and artificial constructions and, on the other hand, they are more concerned with the recognition of urban areas and landscape types rather than individual land parcels uses (Lees *et al.,* 2019).

The main reason of the development of this project is to provide a detailed and fine-grain description of the extent and mechanics of the

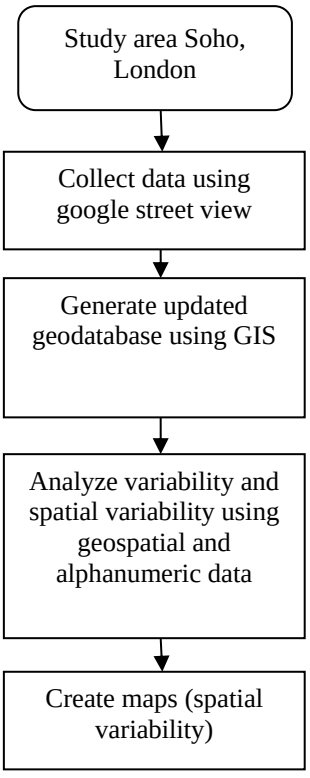
gentrification process considering the city block scale as it is mentioned by Phillips, 2018 and Ip, 2018. The importance to introduce the aforementioned before fine-grain description into a geographic database is to support spatial analysis in order to understand past and present relationships, to identify patterns and to make previsions related with residential and business location. Peter et al. 2018 mention that land use control measures to strike a balance between economic development and land administrative system to foster a sustainable urban cities.

The principal aim of this study is to develop a methodology to keep geographic land-use databases updated, through the use of panoramic photos captured by Google Street View. Since the panoramas from different years are now available, Google Street View could become a new tool to perceive, observe and study neighborhood changes over time. In particular, for Soho, Google Street View provides images from 2008, 2012, 2014 and 2015. Having all these data available through a single interface, it provides a tremendous advantage and opportunity for discovery the spatial behavior of the variable gentrification.

Methodology

In the following scheme (Graph 1) is summarize the steps for this study which are explained in the following paragraphs.

Graph 1.- Summary of the steps for this methodology



Research method

The literature review of this project revealed that most of the studies related to land uses in a neighborhood scale have several limitations. They usually emphasize that the methodology employed is not specific enough to generate accurate results, but just a first estimate of the neighborhood land uses. They highlight that in order to have more truthful results, a more specific methodology is required, maybe including detailed physical and owner/occupier surveys (Glaeser *et al.*, 2018).

In the case study, the Conservation Area Audit identifies the ground floor uses and publishes a periodically updated land use map. Nevertheless, due to the dynamic nature of this area, in which commercial activities and services change every year or even more often, it is difficult to keep an accurate database of the space allocated to different uses (Zuk, 2018). Considering the aforementioned before, this project is done based on an applied research which considered as case study Soho in London which is explained below.

The case study

Soho covers two historic parishes – St Annes, east of Wardour Street and St James to the west. While the St Annes section was laid out according to a regular street pattern with Soho Square as its main public space, the St James section was divided up into a complicated pattern. As a consequence, development was more fragmentary than in St Annes, with more pockets of regular developments. This is the basis of the current street pattern, mixing typical 17th century estate layouts with a more fragmented and tighter urban morphology.

The 1950s also bought jazz bars, beatniks and coffee bars, particularly centered around Carnaby Street, which led on to this area becoming a youth fashion center for London in the sixties. Long also a focal point for the gay community, the gay culture has become particularly prominent in the Old Compton Street area since the 1980s, adding to the liveliness, flux and cosmopolitan character of this part of Soho.

As mentioned above, Soho has been for over half a century a cultural and creativity hub. However, nowadays, it is rapidly turning into a luxury district, populated with upmarket restaurants, trendy clothes shops, coffee bars, groovy office space and big residential developments. In part this is due to market forces, which can take years to percolate into places with long leases, but mainly because of the intervention of the Westminster council (City of Westminster City Planning Group, 2007).

In particular, planning applications have been used to induce these changes. Many nigh-time activities licenses have been restricted, resulting in the closure of some historic bars and theatres, which later turned into available properties that developers could easily buy. This process can be clearly

identified as displacement and it is one of the steps in the gentrification process (City of Westminster City Planning Group, 2007; Zuk, 2018).

As more is invested in an area and property values rise, the poor and working class households and traders that comprise the original population of a neighborhood will no longer be able to afford to stay there, resulting in displacement. While such displacement may be of economic benefit to cities overall as the rising property values increase the tax base, many view it as an unavoidable, socially detrimental consequence that overburdens the original residents, particularly renters in the neighborhood (Nesbitt, 2005; Phillips, 2018).

Although gentrification is first and foremost a residential process, it also entails commercial redevelopment. As the socioeconomic character of the neighborhood changes, retail and recreational facilities adjust to the changing demand (Glaeser, 2018). Old businesses are forced to close and new businesses, serving the needs of the emerging middle class population, enter the neighborhood. As the socioeconomic composition of the neighborhood changes, so it does the perception of acceptable land uses.

In this case, displacement has affected residents and local business in the same way, but the attention has been focused in the cultural and entertainment activities that have been currently disappearing, since once they were the heart of Soho.

Furthermore, gentrification in entertainment areas is a big issue in the UK for two main reasons. First of all, UK's night-time economy is huge and it can be considered as an enormous part of what makes British cities so attractive for both tourists and residents. It's worth £66 billion a year (around 6% of the UK's GDP) and provides employment for 1.3 million people (10% of the workforce). Bars, pubs, clubs, restaurants and theatres have been, in many cases, drivers behind the renaissance in urban living and are a big draw for tourists (City of Westminster City Planning Group, 2007). The second issue is related to diversity. If urban areas are composed by nothing but expensive restaurants and high-class apartments, the mix of cultures, activities and social classes will eventually vanish, resulting in a homogeneous and interesting area (Roberts *et al.,* 2018).

Applied techniques

Another important matter related to this kind of data acquisition is its cost. Traditional methods of collecting land use data by field survey gave the possibility of building cartographic representations in which observations of land use could fit. Then, technology improvements in the form of remotely sensed imagery, particularly in combination with GIS, helped measuring land cover at different scales. But, so far, it is still quite complex to collect data regarding small scales, such as parcels, buildings or floors in order to answer

to local needs related to strategic issues and policy elaboration. Problems like gentrification are still difficult to address due to the lack of current and past specific data (Ip, 2018; Lees *et al.,* 2019). For this project, the technology is an important instrument which means to integrate Geographic Information Systems and Google Street Map in order to accomplish the objective of this research.

Research procedure

This methodology considers Google street map as a possible tool for land-use-data collection. The introduction of previous-years-data is quite recent and obviously this is the key element that makes all the procedure possible. Basically, one just have to drag the pegman from the bottom right corner, then drop it on a street. If past imagery is available, the clock icon in the top left of the map is shown. Clicking on the clock icon, a slider appears and it allows the user to go further back in time. In order to view the historical imagery in full screen, one may need to click the expand button in the bottom-right corner of the preview. This can be done for based on the availability of the images. Based on the information recollected from Google street map, the next step was the creation of the updated geodatabase using ArcGIS in which was possible to introduce alphanumeric data related with the changes of land use by block.

The geospatial data was linked to the alphanumeric data in order to determine the land use categories during the years 2008, 2010, 2015 and 2018, and to analyze the variability trough the mentioned years. The variability analysis was presented by maps using Geographic Information Systems, the software ArcGIS was used for this project.

Results:

For the specific case of Soho, it was created a database that included each single parcel within the area of Soho: 1367 polygons represented the ground floor use of each parcel and the main attributes of those polygons consisted of the use category and the specific name of the activity allocated during each of the four years under study (2008, 2012, 2014, 2015).

Moreover, there were other fields indicating what kind of changes occurred and when they took place. Three kind of changes were considered: category change, when for instance a property use changed from residential to commercial; class change, when the use varied within the same category, for example, when a bakery turned into a clothing store; and brand change, when the land use did not change, but the name of the activity was actually different, either because the owner had changed or because the local suffered some kind of internal or external renovation.

Finally, a field called variability was included, which was measured from 0 to 3, and represented the number of changes that a specific property suffered or not throughout the study period. As a result, parcels that did not present any change were included in the "no variability" class, parcels that showed one change were classified as "low variability", and so forth.

Land uses were grouped into categories that were created to reflect the main characteristics of the neighborhood and the nature of the changes that occurred in the area since 2008, highlighting the typical land use transformation that is generated by a gentrification process. Arts, crafts, decoration and hobbies; basic urban services; beauty and health; fashion; food; technology; money services and agencies; nightlife and entertainment; urban renewal and demolition; residential, offices, warehouses and parking; department store; no data.

Land use changes

Using ArcGIS it was possible to prepare land-use maps that helped us to visualize the changes that occurred in Soho from 2008 to 2015. Moreover, Table 1 summarize these changes, which are visible in Figure 1.

As expected, there is a gradual decreasing in the percentage of nightlife and entertainment activities caused by the planning applications mentioned above; while in 2008 this category represented the 12% of the total allocated land, by 2015 it was reduced to the 8%. Similarly, the category of art, craft, decoration and hobbies, which includes book, music and magazine little stores, as well as small artist and craftsman shops, decreased by 5% in those years. Furthermore, the money services and agencies, which includes also banks, but mainly money exchange agencies and souvenir shops, presented a slight reduction.

On the other hand, other categories such as fashion (1%), food (2%), beauty and health (1%) and residential and offices (2%) increased. Also the percentage of land dedicated to basic urban services augmented by 2% in those years. This kind of land use changes are natural in areas around the city centre. As housing in London becomes more and more scarce, property developers start to recognize the value of boroughs near the Central Business District, and they want to attract the right kinds of investors. And it is obvious that these investors prefer other uses rather than late night activities.

Moreover, since the database included the name of each activity and not only the category, it was possible to appreciate another distinct feature of this transformation: as you walk up and down the streets of Soho today, you would note the overwhelming presence of brand-name stores, while smaller boutiques, specialty stores, artist and craftsman shops and galleries are always fewer in number.

Figure 1.- Land use maps for 2008, 2012, 2014 and 2015

Table 1.- Land use categories in 2008,2012,2014,2015

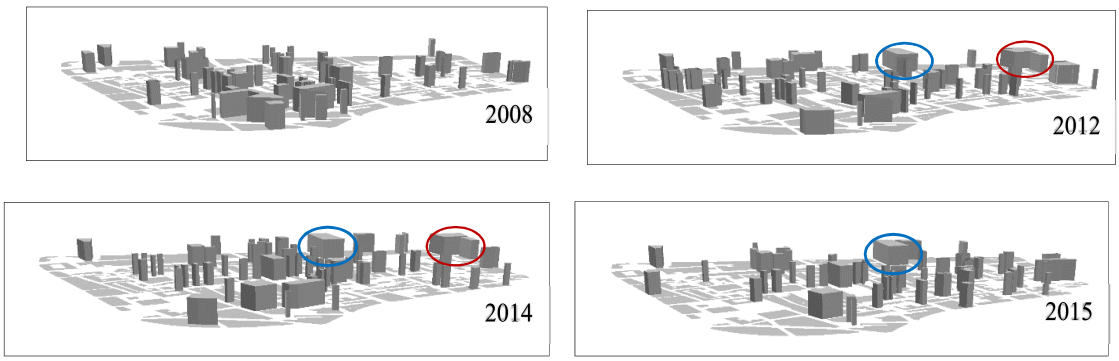
Land-use categories	2008	2012	2014	2015
Arts, crafts, decoration and hobbies	8%	6%	4%	3%
Basic urban services	2%	2%	3%	4%
Beauty and health	5%	5%	6%	6%
Fashion	15%	16%	16%	16%
Food	23%	24%	24%	25%
Money services and agencies	3%	3%	3%	2%
ND	1%	2%	2%	2%
Nightlife and entertainment	12%	10%	9%	8%
Residential, offices, warehouses and parking	23%	23%	24%	25%
Technology	1%	1%	1%	1%
Urban renewal and demolition	7%	8%	8%	8%

Urban renewal and demolition

Another particular feature of the transformation of Soho that one may notice is the high amount of urban renewal and demolition interventions. In 2007 the Westminster government present the Soho action Plan, in which 11 out of 65 action were dedicated to urban renewal, among them: make necessary physical improvements to Beak, Kingly and Warwick Street; implement the 'Open Spaces Strategy' including biodiversity and reviewing

access for disabled people and looking at ways of enhancing Golden Square; carry out green audit of Soho and review recommendations for implementation ; promote an improvement scheme for the area around Berwick Street; proactively work towards regeneration of the area in and around Great Windmill Street and Ham Yard; make improvements to the Marshall Street Leisure Centre; revitalize the area. In the following 3-D maps, the buildings under urban renewal and demolition interventions are presented for each year, illustrating the intensity and dynamicity of these interventions, as well as highlighting the most affected areas (Figure 2).

Figure 2.- Urban renewal and demolition 3D representations (2008, 2012, 2014, 2015)



Since then, a great number of interventions has been carried out, old markets, historic bars and theatres, but also rundown buildings were demolished to construct new residential and office towers. As a result, numerous organizations have been created with the intention of protecting Soho from gentrification, the most famous one is called “Save Soho” and some well-known faces from the entertainment world are part of it. Nevertheless, local authorities and planning experts support the plan, claiming that the current interventions will bring an enormous improvement in people’s quality of life in the long run. However, one issue in particular is to be considered, Soho presents several historical buildings that must be protected, as well as several activities that have been the heart of this neighborhood for decades and, therefore, should be enhanced rather than banned.

One of the main interventions that have been carried out in Soho during the study period is the rebuilding of the Totenham Court Road station. As one may see in the Figure 3 and Figure 4, it has had a great impact in the area since the Crossrail proposals for the western ticket hall and the associated emergency escape and ventilation shaft at Tottenham Court Road required the demolition of two blocks of buildings to the south of Oxford Street, between Great Chapel Street to the west and Dean Street to the east.

Figure 3.- The junction of Oxford Street and Charing Cross road (red circle in the 3-D representations) Source: Google Street View

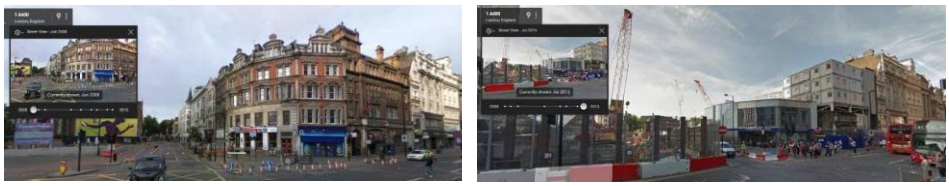
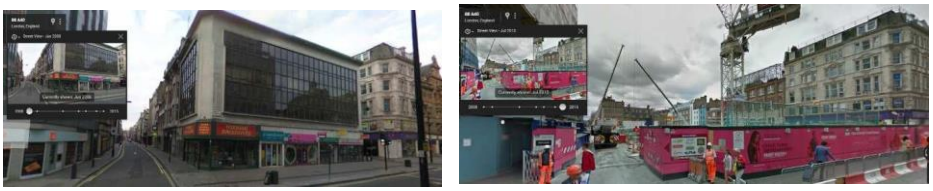


Figure 4.- The junction of Oxford Street and Dean Street (blue circle in the 3-D representations) Source: Google Street View

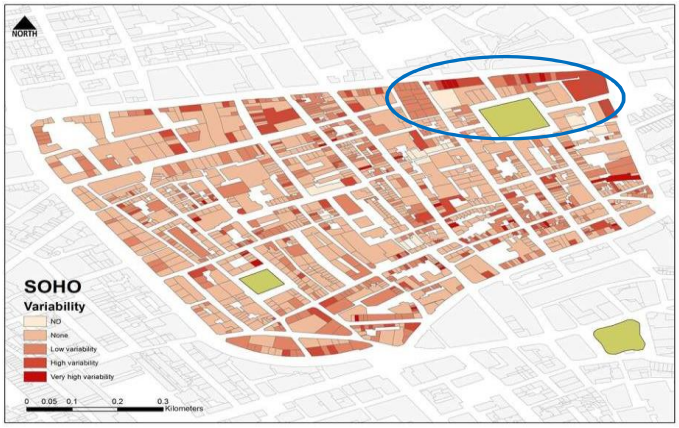


Nevertheless, due to this in intervention the demand of the station is expected to increase by 30%. Moreover, the complex planning and engineering project to rebuild the station improved the transportation in the whole capital and a public plaza outside the stations was created, with wider pavements, better cycling and bus facilities.

Variability

As mentioned above, the geodatabase considered a field called variability, which measures the level of changes that a particular parcel has suffered throughout the study period. When speaking about changes, it refers to category changes, class changes and brand changes (explained above). But since urban renewal and demolition were considered as a category, it becomes obvious that every time that a property undertook a renewal transformation, its level of variability increased. Consequently, as one may see in the Figure 5, the areas with the highest level of variability, are the ones affected by the rebuilding of the Totenham Court Road Station, which besides the urban renewal, suffered a series of land-use changes.

Figure 5.- Variability map



Moreover, in the Table 2, it is possible to observe the relationship between each land use category and each level of variability for all the study period.

In 2008 and 2012, "technology" seemed to be the most variable category (considering both high and medium variability), while for 2014 and 2015, "basic urban services" were the category with the highest variability, since in those years several parcels were temporarily affected by the crossrail rebuilding. Nevertheless, "food" and "fashion" presented an interesting level of variability throughout all the study period. On the other hand, "residential and offices" do not show any variability. This may be due to the fact that normally when a property becomes residential or offices, it rarely changes again. Regarding the offices variability, it could be noticed that in contrast to the general trend (which indicates that small business are despairing and big companies are dominating the area), the number of small startups have been increasing from 2008. Unfortunately, those are the major contributors to the reduce number of changes related to this category.

It is important to emphasize on the fact that the total amount of parcels related to "technology" and "basic urban services" is widely larger than the amount of parcels classified as "food" and fashion". As a consequence, a comparison may not be possible.

Table 2.- Variability and land use for 2008, 2012, 2014, and 2015

2008				
Categories	no	low	medium	high
Arts, crafts, decoration and hobbies	44%	35%	18%	3%
Basic urban services	81%	13%	6%	0%
Beauty and health	61%	26%	14%	0%
Fashion	55%	27%	16%	2%
Food	52%	30%	13%	4%
Money services and agencies	45%	45%	7%	2%
Nightlife and entertainment	68%	16%	14%	1%
Residential, offices, warehouses and				

parking	89%	10%	1%	0%
Technology	40%	35%	20%	5%
2012				
Categories	no	low	medium	high
Arts, crafts, decoration and hobbies	54%	35%	10%	1%
Basic urban services	76%	18%	6%	0%
Beauty and health	50%	38%	10%	3%
Fashion	55%	30%	12%	2%
Food	49%	34%	12%	5%
Money services and agencies	51%	41%	8%	0%
Nightlife and entertainment	76%	14%	10%	0%
Residential, offices, warehouses and parking	92%	8%	0%	0%
Technology	50%	25%	25%	0%
2014				
Categories	no	low	medium	high
Arts, crafts, decoration and hobbies	57%	33%	10%	0%
Basic urban services	60%	17%	24%	0%
Beauty and health	51%	37%	10%	3%
Fashion	58%	30%	11%	1%
Food	47%	36%	15%	2%
Money services and agencies	46%	41%	7%	5%
Nightlife and entertainment	81%	13%	6%	0%
Residential, offices, warehouses and parking	94%	6%	0%	0%
Technology	57%	21%	21%	0%
2015				
Categories	no	low	medium	high
Arts, crafts, decoration and hobbies	52%	33%	14%	1%
Basic urban services	45%	11%	44%	0%
Beauty and health	49%	37%	11%	2%
Fashion	56%	29%	13%	2%
Food	47%	35%	15%	4%
Money services and agencies	58%	36%	6%	0%
Nightlife and entertainment	84%	12%	4%	0%
Residential, offices, warehouses and parking	93%	6%	1%	0%
Technology	58%	25%	17%	0%

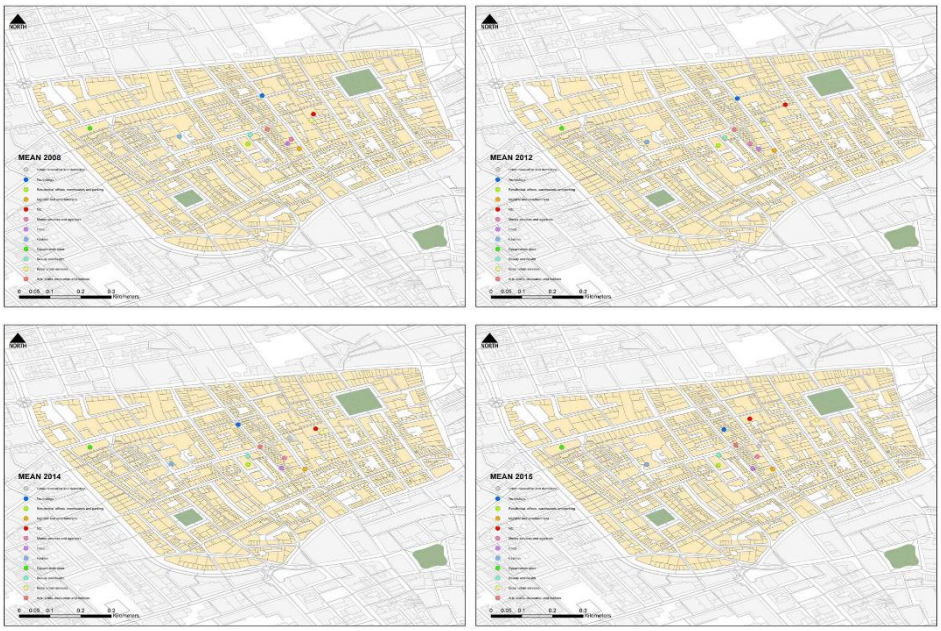
Finally, we could also notice that there is also another kind of land use variability, not related to category, class and brand changes of the same property, but to the spatial distribution of the land uses within Soho. The maps in the Figure 6 are highlighted in order to analyze this specific kind of spatial variability.

Spatial variability

These maps (Figure 6) highlight the spatial variability of land uses in Soho. Using the mean center, a geoprocessing tool aimed at identifying the geographic center for a set of features, it could be visualized the great spatial

variability that land uses show in Soho, as regardless the reduced extension of this area, the centroids are constantly moving from year to year.

Figure 6.- Spatial variability for 2008, 2012, 2014, and 2015



Conclusions:

The nature of the Google Street View platform presents some limitations for the data collection process.

- The lack of past imagery. In some streets, the years 2008 and 2012 were not capture and, therefore, it is not available. In this case, the database was fulfill with the voice ND "no data".
- The difficulty to identify a specific land use in a particular street due to the presence of visual obstacles in the images, such as buses, trucks, etc.
- Google street map cannot collect data along walkable streets. Sometimes, it is possible to obtain information about the uses in those kinds of streets due to the coverture of panoramic photos. However, the difficulty may lead to errors.
- In certain locations, without any evident reason, the platform present some malfunctions, sending the pegman to a different position in relation to the requested one.
- Even if the panoramic photos are a great source of land use data, the methodology adopted in this study is very time-consuming. Google Street map would be considered as an important tool in this field, if somehow the data were storable and downloadable. This may be achieved through the inclusion of Volunteered Geographic Information: people could introduce land use data

into a Google Street map database, which would be immediately available to the public.

- Regarding the gentrification in Soho, it is important to consider that the current Action Plan was approved in 2007, so the changes that were highlighted in this project (which are the same that the neighbors have been noticing in the last years), are just the first results of the Plan implementation. In this context, the community must be prepared to face greater changes in the short and long run, if they want to defend the architectural heritage and the cultural diversity of his area.
- It is also fair to admit that some of the urban renewal interventions carried out in the last years had positive impacts on the image of Soho and the quality of life of its inhabitants.
- The principal advantage of this methodology is related with the updated geodatabase which is helpful to study the spatial variability of Soho. Also, it is possible to obtain maps which illustrate the land use change for gentrification.
- The methodology of Peter et al. 2018 use descriptive statistics to analyze the change on neighborhood qualities but the methodology for this study use an update geodatabase in order to obtain the spatial variability related with the change of land use for gentrification which improve the analysis and the understanding with spatial variability maps.

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