

XXVIII International Seminar on Urban Form  
ISUF2021: URBAN FORM AND THE SUSTAINABLE AND PROSPEROUS CITIES  
29<sup>th</sup> June – 3<sup>rd</sup> July 2021, Glasgow

**A diachronic investigation of social inequality and spatial segregation in the District of Columbia**

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**Abstract**

*Washington DC is one of the gravely affected urban areas by social inequality and its effects. According to the Gini Index of the Population Reference Bureau, the District of Columbia carries an income inequality of 52.8%, the highest percentage within the United States. In this inquiry, we aim to uncover the diverse patterns of inequality and their potential interrelations with the urban form in the District of Columbia in three levels. (1) Mapping inequality: We diachronically map spatial data about land value, household income, race and ethnicity, school and healthcare accessibility and rating, crime data and Covid-19 data. (2) Analysing urban change: We compare and analyse specific areas of the district according to the changes that we track in the diachronic mapping and find potential depriving and decaying areas as well as gentrifying areas. (3) Relating to urban form: We attempt to make sense of these patterns of urban change by relating them to urban form on two levels by means of street network analysis where we analyse the closeness centrality (integration) of street segments and then compare the built form characteristics and urban density measures using Noll maps. Through this methodology, we aim to reveal how social inequality and spatial segregation issues relate to urban form in the District of Columbia case.*

**Keyword:** *Diachronic research, social inequality, spatial segregation, District of Columbia*

**Introduction: Inequality, segregation and gentrification in the US**

Social inequality is a fundamental problem of urban space that triggers unsustainable and unjust urban development through spatial segregation, decay and gentrification. It undermines social cohesion (UNDP, 2013), entails diverse urban issues such as deprivation, poverty, homelessness and crime. The lack of access to resources in health, education and social activities, results in disparities among certain groups of people. Studying patterns of racial and ethnic segregation matters in order to understand social inequality and spatial segregation, because these patterns are closely related with the correlation between a group's location and socioeconomic status (Massey, 2001). However, understanding segregation as a notion and a process is significantly complex and multi-dimensional (Vaughan&Arbaci, 2011; Maloutas, 2004, p.4). The difficulty in defining segregation lies in the uncertainty when defining difference between groups of people (Mateos, 2011, Vaughan&Arbaci, 2011).

Our hypothesis in this case study is that the amount of certainty in inequality patterns between groups of people correlates with the amount of segregation. The first part of this hypothesis states that in the patterns that offer less social mixing, and the groups are clustered in themselves, spatial segregation levels will be higher. In some residential patterns in the US cities, spatial segregation is apparent. We see especially that

Black residents are more likely to live systematically disadvantaged neighborhoods compared to White residents of similar income levels (Schneider and Logan, 1982; Massey and Fong, 1990; Massey, 2001). Black residents suffered from these clear residential segregation patterns and redlining in our case Washington DC (DC-PIRG, 1975; Lloyd, 2015), and along with other disadvantaged and underprivileged communities, they still face challenges of exclusion and gentrification.

The second part of the hypothesis is that in the patterns that offer more social mixing, spatial segregation levels will be lower. However, that does not mean that the society becomes more equal in these spaces that offer social mixing. Segregation does not only imply a spatial segmentation. Netto (2017) suggests that territorial (spatial) segregation is not the only to be held accountable for segregation and that the spatiality of our daily actions also contribute to social segregation. Social segregation remains possible in seemingly socially mixed areas such as gentrified areas in the city centres. “Gentrification is a process of socio-spatial change in which the working-classes are displaced by the middle-classes and the residential and commercial landscape is upgraded” (Cocola-Gant, 2019). Gentrification complicates segregation even more, by creating different dynamics of encounter during this displacement process. In gentrifying areas, while encounters between groups of people increase, social segregation remains an issue, as the amount of contact between socially different people may remain low. Given the scope of this study, we only concentrate on the effects of residential segregation in our case, while we are aware that it does not constitute the entirety of the segregation patterns in a city.

### **Methodological approach for the case of DC**

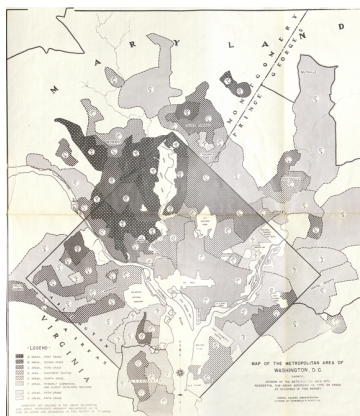
The United States displays a significant “increase in social inequality, polarization, poverty and misery” (Castells, 1998). Many cities and metropolitan areas including Washington DC face social inequality as a challenge. Washington DC historically shows segregated patterns. Our case study, The District of Columbia only constitutes the central part of Washington Metropolitan Area, comprising parts of Maryland and Virginia that can be reached with an underground railway system. Among the counties and the district of Washington Metropolitan Area, the centre – also the capitol the District of Columbia is the one that is the most gravely affected urban area by social inequality and its effects. According to the Gini Index of the Population Reference Bureau, the District of Columbia carries an income inequality of 52.8%, which is the highest percentage within the United States between the years 2014-2018, and also higher than the middle-income countries of the Latin American and the Caribbean regions (Ortiz and Cummins, 2011; Rohwerder, 2016). The District of Columbia struggles with a variety of reasons that contribute to social inequality. To uncover these diverse patterns of inequality and their potential interrelations with the urban form in the District of Columbia. We explore inequality and segregation in the District of Columbia in three levels: Mapping inequality, analysing urban change and relating to urban form.

- (1) Mapping inequality: We diachronically map spatial data about land value, household income, race and ethnicity, school and healthcare accessibility and rating, crime data and Covid-19 data. We aim to bring this multi-dimensional approach when tackling inequality in the District of Columbia, to be able to identify patterns of inequality and segregation through time. We offer a historical racial segregation section in the first part of the study, which aims to make sense spatial segregation as a potential result of historical systemic racism.
- (2) Analysing urban change: We compare and analyse specific areas of the district according to the changes that we track in the diachronic mapping and find potential depriving and decaying areas as well as gentrifying areas. This section presents significant research material to identify new patterns of change during the last ten years, however it also shows signs of historical patterns of exclusion. We aim to find out which areas have been significantly changing, through deprivation, decay, gentrification or renewal.
- (3) Relating to urban form: We attempt to make sense of these patterns of urban change by relating them to urban form on two levels by means of street network analysis where we analyse the closeness centrality (integration) of street segments and then compare the built form characteristics and urban density measures using Nolli maps. For each neighbourhood, we specify a walking distance (800m diameter) circular area, to allow each case to be compared to each other in terms of street network analysis and urban density.

### **Mapping inequality in DC**

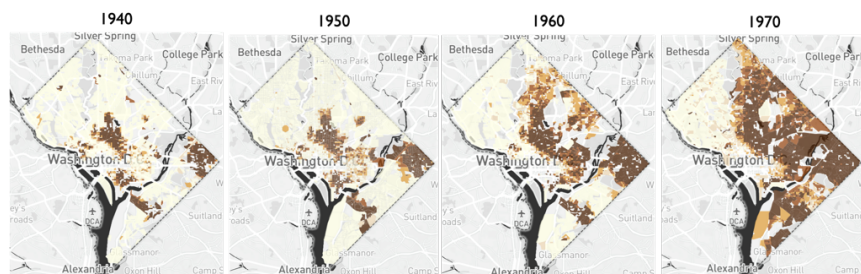
In this section, we diachronically map spatial data about land value, household income, race and ethnicity, school and healthcare accessibility and rating, crime data and Covid-19 data. We give historical insights about racial inequality that the city has faced for over a century, and comment on how redlining has shaped today's Washington DC. Then we concentrate on the last 10-year change, especially because we can access meaningful and computable data from US Census Bureau since 2009. We look at possible changes on the census data in the last decade to understand urban change and make sense of inequality.

Blacks were historically segregated in the Washington DC area. The government restricted the use of space for the Black community prohibiting them to own or rent a house from the banned areas. This process is often referred as redlining. The map provided below dates from 1937; it indicates areas ranging from A to H, signifying the level of "residential quality" from the first grade through the sixth grade. Referring to the explanation of the grading system, the lowest grade signifies the areas where black people can reside. This map – among many other maps that grade residential areas in the US around the same time, considers race the main criterion to grade residential areas (Cherkasky et al, 2021). We can conclude that systemic racism is embedded even in spatial practices for over a century in the case of Washington DC.



**Figure 1.** Redlining in the Washington DC area, FHA (Federal Housing Administration) Residential Sub-Areas, 1937 (NARA)Map, 1937, accessed through Mapping Segregation DC website (Cherkasky et al, 2021).

Washington DC suffered from three main problems during the 20th century in terms of spatial segregation due to racial discrimination. The first one is – previously mentioned term “Redlining”. “Jane Jacobs was the first to document redlining, calling it ‘credit blacklisting.’” (Lloyd, 2015, p.1093; Jacobs, 1961). The initiation of redlining lies in Home Owners Loan Corporation (HOLC) security maps based on race and ethnicity of the 1930s (Lloyd, 2015; Jackson 1980; Jackson, 1985). Redlining consists of “illegal discriminatory practice (...) restrict[ing] services to certain areas of a community, often because of the racial characteristics” (Britannica Encyclopaedia, 2021). Redlining manifested as “racial covenants” in DC, becoming an ineffective law after 1948 when restricted areas became available for black buyers. This resulted in a change in the emplacement of Black residents, moving towards east and north (Figure 2).

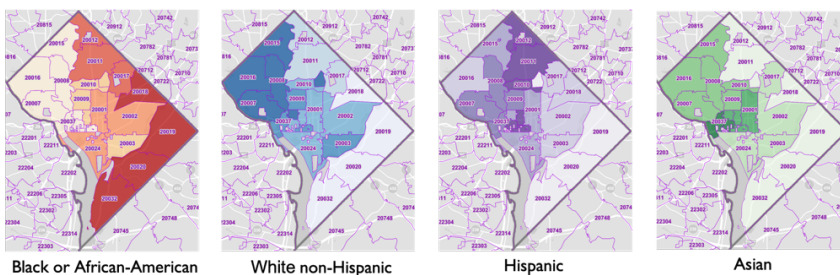


**Figure 2.** Black residents through history, accessed through Mapping Segregation DC website (Cherkasky et al, 2021).

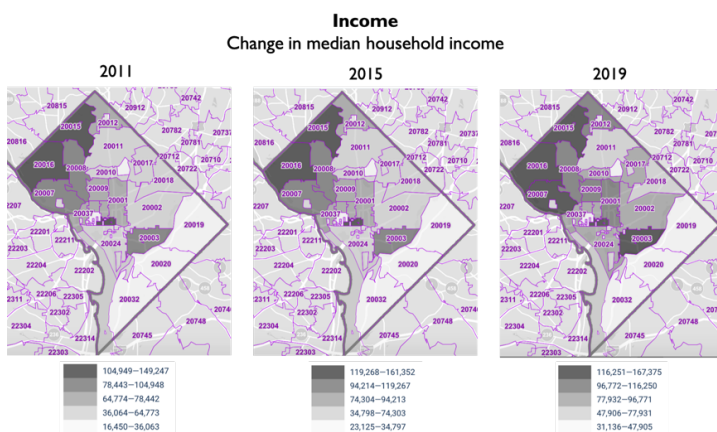
The second problem was about the seclusion of the disadvantaged groups – especially Blacks – in the alley dwellings. Alley dwellings consist of secluded interior alleys located inside urban grids. They include houses that are not facing any street offering poor living conditions, cheap materials, increased rent. Between 1850s and 1940s alley dwellings are abundant. By the end of the 1800s, almost all of DC’s 16,000 alley dwellers were Black. After 1950’s, most alleys disappear. Black residents were displaced, and alley residences were sold to White residents. (Cherkasky et al, 2021). The most known alley (Blagden Alley) has gentrified. The third problem was excluding some groups of residents in public housing created in deteriorating neighbourhoods during the 1945-1960 period as post-war housing and between the 1960s-1980s under the

name of Federal Urban Renewal Projects (Cherkasky et al, 2021). This also contributed to deprivation for dwellers in those areas, definitively isolating Black residents in particular.

In 2019, according to the census data provided by the US Census Bureau, we see an apparent spatial segregation based on racial and ethnic backgrounds (Figure 3). We contemplate a high percentage of White non-Hispanic people in the Northwest area, Hispanic people in the North and Black people in the Northeast and Southeast. We may conclude that the historical patterns of discrimination contributed to today's residential segregation in DC. We diachronically investigated income levels between 2009 and 2019 (Figure 4). The data shows that the highest income concentrates along the northwest where Whites and Asians live. Lowest income levels concentrate in Southeast and Northeast areas where Hispanic and Black communities live. We also see that the lowest median income values increase. This may mean that people with lowest income earn more, but it may also mean that each year, more people cannot afford to live in DC and eventually leave DC. We have investigated school ratings and identified patterns of low student performance in lower rated schools located in segregated neighbourhoods –with Black residents, with less variance in the racial background of students. Higher rated schools where students perform better are located in either white segregated neighbourhoods or the city centre but have a high variance of student racial background. Other data, like the percentage of Covid-19 cases and health disparities per neighbourhood show that there is a significant amount of social inequality causing multiple deprivation for underrepresented communities.



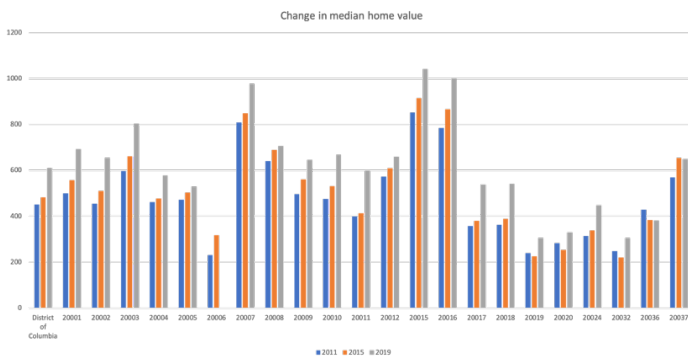
**Figure 3.** 2019 choropleth maps for origin of the householder per occupied housing unit for White non-Hispanic, Hispanic, Black and Asian householders, source: US Census Bureau.



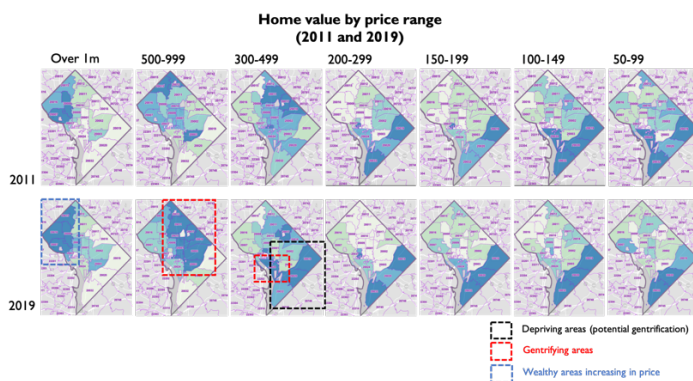
**Figure 4.** 2011, 2015 and 2019 choropleth maps for median household income, source: US Census Bureau.

### Analysing urban change

According to the data we have acquired in the previous section, we compare and analyse specific areas of the district according to the changes that we track in the diachronic mapping and find potential depriving and decaying areas as well as gentrifying areas. We especially tackle diachronic change of median home value per ZIP code, home value and price range change between 2011 and 2019 for designating areas that carry the potential of depriving, gentrifying or already wealthy area increasing in price (Figure 5 and 6). Most ZIP code areas with an increasing grey (2019) bar are gentrifying. Lower value clustered bars are depriving neighbourhoods, with higher 2019 bars at the end are likely to gentrify or has just started gentrifying. Higher value clustered bars, representing wealthy neighbourhoods also have their 2019 bars increasing. Only three areas lack of a significant value increase, and these areas exactly match with depriving areas in the Southeast (Figure 5). Furthermore, we compared home values by price range between 2011-2019. We argue that the Northwest cluster constitutes the wealthy area with increasing home values, the North and centre cluster constitutes potentially gentrifying areas. Although, we did not see a specific pattern in home value increase in the previous chart, we can identify a decent change in price range in the Southwest. We are investigating what happens in particular in these changing neighbourhoods in the next section looking at the specifics of built form an urban density measures for each of these neighbourhoods.



**Figure 5.** 2011, 2015 and 2019 clustered bar chart illustrating the change in median home value, source: US Census Bureau.



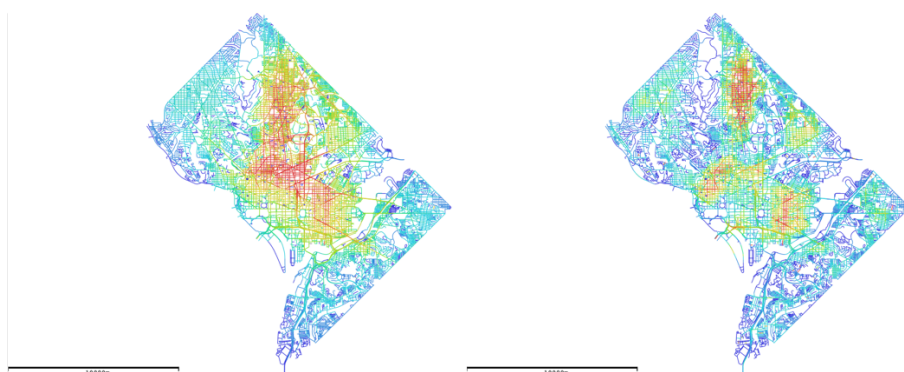
**Figure 6.** 2011, 2015 and 2019 clustered bar chart illustrating the change in median home value, source: US Census Bureau.

## Relating to urban form

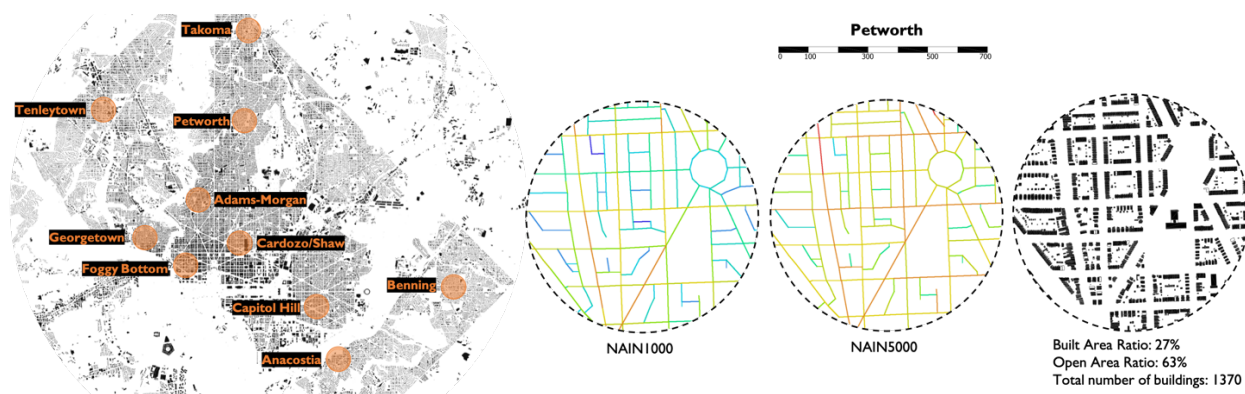
In the previous section “Analysing urban change”, we have discovered patterns of inequality. In this section, we ask if these patterns of urban change are affected by urban form. We attempt to answer this question by proposing a comparison method on two levels: The closeness centrality (integration) of street segments and the built form characteristics and urban density measures using Nolli maps.

The closeness centrality of street segments is a Space syntax method involving the integration of segments in the entire system or a local system (such as a particular distance – 800m). “Integration describes how easy it is to get to one segment from all other segments” (Charalambous& Mavridou, 2012). “Normalised angular integration (NAIN) aims to normalise angular total depth by comparing the system to the urban average” (Hillier et al, 2012).

We investigated global and local patterns of integration using NAIN5000 (radius 5 km) for extracting global Integration patterns, NAIN1000 (radius 1 km) for extracting more local integration patterns (Figure 7). The analysis NAIN5000 (global integration) on the right demonstrates that two areas (Northwest and Southeast) seem extremely segregated. The centre of the city towards north and south axis in both directions seems more globally integrated. This means that White residents in the Northwest are located in a segregated part of the city – this segregation may be a self-segregation. However, Black communities located in the Southeast part of the city have been historically excluded from the city, as a result of the aforementioned discriminatory processes in the city. The NAIN1000 local integration analysis indicates that the city centre and the north part of the city are more locally integrated. These patterns match almost perfectly with the location of the Hispanic communities in the North and gentrifying neighbourhoods’ locations in the city centre. Hispanic communities may have been obliged to stay together for surviving as a community. Gentrifying neighbourhoods provide new hubs that are located generally in locally integrated areas of the city. We additionally investigated neighbourhoods to uncover patterns of segregation and gentrification on the micro scale. We analysed built form characteristics and urban density measures using Nolli maps on a local walking distance scale (800m): we have examined 10 neighbourhoods that showed different characteristics in terms of income, value, race and urban form (Figure 8). We discuss our final findings in the conclusion section.



**Figure 7.** Closeness centrality of street segments in DC: NAIN5000 on the left, NAIN1000 on the right.



*Figure 8. The neighbourhoods investigated on a local walking distance scale*

## Conclusions and remarks

Our final findings indicate that residential areas with single family houses differ in urban form and density: In wealthier areas, the average residential building area is larger than deprived areas. In contrast, we can find a higher density of buildings with a high number of more compact building area –hence a lower home value. These areas with high amount of the same typology of residential buildings tend to offer less social mixing and high level of social segregation in each racial group. Also, highly locally integrated areas are more likely to gentrify. Gentrified areas tend to have a variety of building types, especially in areas where depth is increasing (like alley dwellings). Lastly, segregated areas tend to accommodate less ordered and sometimes sparse building patterns. Usually street networks are stricter, but the built form is less rigorous and more diverse.

Our findings partially confirm our hypothesis: The amount of certainty in inequality patterns between groups of people correlates with the amount of segregation. In the patterns that offer less social mixing, and the groups are clustered in themselves, spatial segregation levels will be higher. Globally segregated patterns of urban form tend to also be racially segregated as well. However, segregated micro-scale patterns show that urban form is strictly different in integrated and segregated areas and even so in different types of segregated residential areas belonging to different social groups – urban form varies as segregation types differ.

We cannot verify the second part of our hypothesis – the patterns that offer more social mixing, spatial segregation levels will be lower. Some communities (Hispanic) that stay introverted are still locally integrated, whereas gentrified areas have a variety of social groups in themselves. We cannot conclude that social mixing resulting from gentrification prevents segregation. To understand these conditions, we must research further the relationships between the variables namely built form, land use, accessibility to public amenities/services, integration and social segregation patterns arising from encounters and not only residential patterns.



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