Using a Sankey Chart to Visualize Racial and Ethnic Neighborhood Change in Washington, D.C.

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Abstract

Washington, D.C., has experienced demographic change for the past century. These changes across neighborhoods can be multidimensional and complex to convey. This article uses three visualizations to show racial and ethnic change in Washington, D.C. In particular, the Sankey Chart shows how the dominant racial and ethnic group changed at the neighborhood level from 2010 to 2020, including between different categorizations.

Racial and Ethnic Change in Washington, D.C.

Washington, D.C., has been called the most gentrified city in the United States (Richardson, Mitchell, and Franco, 2019). The District of Columbia, like many other cities, peaked in population in 1950. Soon after, the creation of highways, suburb expansion, and White flight began to deplete the city's total population (Frey, 1979). The 1968 riots further fueled the overall population decline (Walker, 2018). The Black population peaked around 1970 in both absolute numbers and population share, as exhibit 1 shows. Although the chart in exhibit 1 is informative at the citywide scale, it does not show change at the neighborhood level.

Exhibit 1

Population by Race and Ethnicity in Washington, D.C., 1920–2020
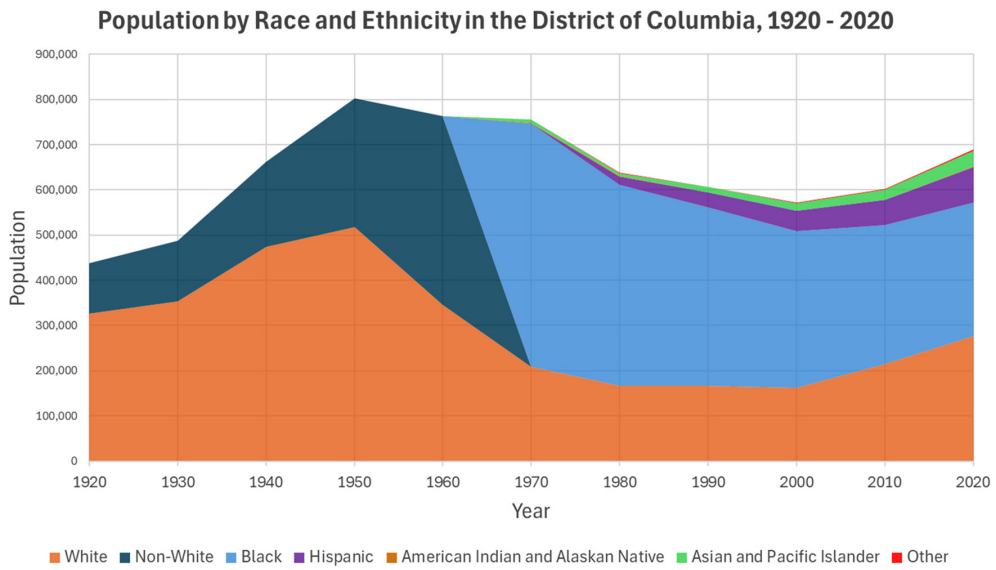
Note: See exhibit 4 in the appendix.

Sources: Census Bureau data from IPUMS NHGIS (Manson et al., 2023); author's visualization

Major demographic changes occurred in Washington, D.C., during the past century. Neighborhood-level changes included alley clearance in Foggy Bottom in the 1970s and residential turnover in Mount Pleasant in the 1980s (Summer, 2022; Williams, 1988). Population loss reduced the city's tax base. In the 1990s, the U.S. Congress created the Financial Control Board to oversee the city's finances because of its mounting debt. Chief Financial Officer Anthony Williams sought to fix the District's finances by attempting to attract more than 100,000 new residents to Washington, D.C., to take advantage of the "return to the city" movement (Hyra, 2015; Rivlin, 2003; Sturtevant and Jung, 2011). This movement set the stage for the past 2 decades of gentrification in Washington, D.C. The city changed from being more than 71 percent Black in 1970 to less than 50 percent Black by 2011 (Tavernise, 2011). The loss of Black residents is a quantitative measure typically associated with gentrification (Jackson, 2015). The purpose of this article is to show how a Sankey Chart, which can visualize changes in population flows, illustrates racial and ethnic neighborhood-level change in Washington, D.C.

Mapping Racial and Ethnic Change by Neighborhood in Washington, D.C.

The juxtaposed categorical choropleth map in exhibit 2 shows the largest racial and ethnic group harmonized to 2020 census tracts and overlays 2022 political ward boundaries. Three racial and ethnic groups are the majority racial or ethnic group in Washington, D.C., neighborhoods: "White non-Hispanic," "Black non-Hispanic," and "Hispanic of any race." These groups are the majority

by varying thresholds.[1] The map on the left shows Washington, D.C., in 2010, and the map on the right shows the city in 2020. The western half of the maps are mostly White, and the eastern half of the maps are mostly Black. Most White-majority census tracts appear to have a super majority of White residents.

Exhibit 2

Largest Racial and Ethnic Groups by Census Tract in Washington, D.C., in 2010 and 2020
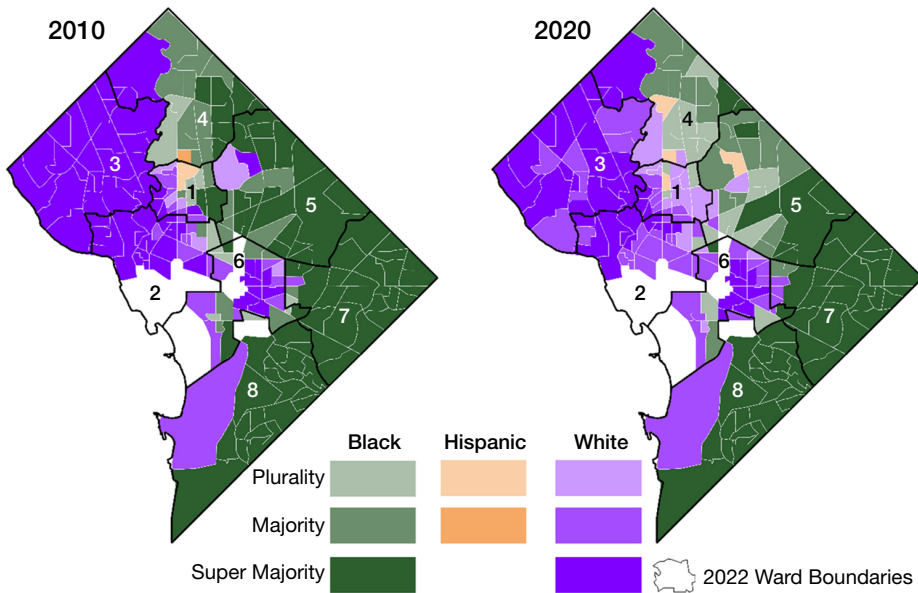
Notes: The map omits census tracts with fewer than 100 residents. Ward boundaries from 2022 are the most recent boundaries available. The numbers on the map indicate wards. Further descriptions of the maps are available as tables in exhibits 5 through 7 in the appendix.
Sources: Census Bureau decennial census data; ward boundaries are from Open Data DC; author's analysis

The map on the right shows the largest racial and ethnic group in 2020 and the majority threshold. The White/west and Black/east pattern largely remains. However, many more lighter shaded census tracts are on the 2020 map, suggesting that the largest racial and ethnic group in those census tracts is now a plurality. The western portion of the city, which previously had exclusively super majority White census tracts, now has multiple majority White census tracts. White plurality census tracts have appeared further east in 2020 than in 2010, particularly in Ward 1. Nearly all census tracts in Wards 7 and 8 and in the southern portion of Ward 5 remained super majority Black in both 2010 and 2020. In contrast, super majority Black census tracts in Ward 4 and northern Ward 5 changed to majority Black census tracts. The small cluster of Hispanic census tracts does not remain, and the four plurality Hispanic census tracts appear more dispersed.

The maps in exhibit 2 provide great insight into racial and ethnic change at the neighborhood level, but understanding the flow of how the census tracts are changing can be difficult. For

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[1] Thresholds are defined as *super majority*, where the dominant group accounts for 66.7 percent or more of the census tract's population. *Majority* is where the dominant group accounts for between 50.0 and 66.6 percent of the census tract's population. *Plurality* is where the largest group has a share of less than 50.0 percent of the census tract's population.

example, Black plurality census tracts grew from 12 in 2010 to 20 in 2020. Still, only one census tract had a Black plurality in both periods. What happened to the other 11 census tracts? What were the other 19 census tracts?
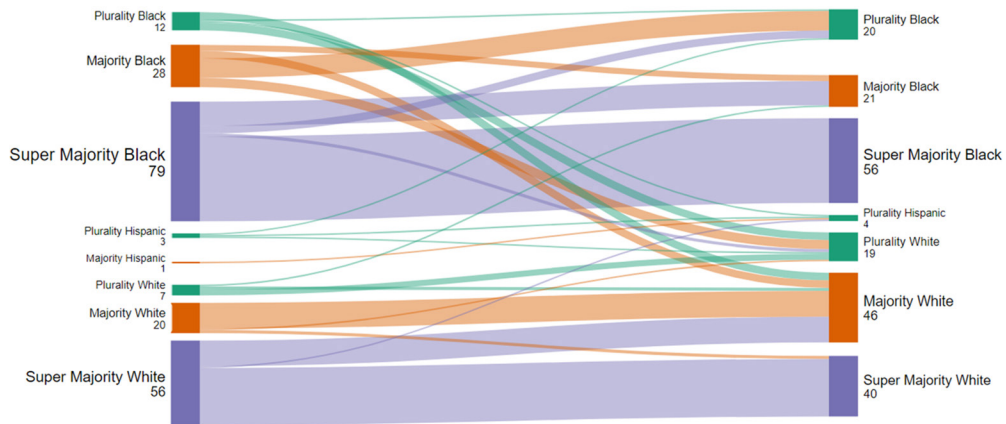
Sankey Chart

Sankey Charts are widely used in engineering fields but not commonly used in social science research. Some uses of Sankey Charts in the social sciences include neighborhood-level analyses to show change in predominant land use and land cover types in Philadelphia (Locke et al., 2023), uncertainties in assigning Rural Urban Commuting Area Codes to census tracts (Fowler and Cromartie, 2023), relationships between redlining and the Social Vulnerability Index (DSL and NCRC, 2023), and relationships between redlining and the Area Deprivation Index (Carlos et al., 2023).

Sankey Charts use counts to visualize flows along arcs between nodes (Otto et al., 2022). In the Sankey Chart in exhibit 3, the nodes on the left represent census tract-level racial and ethnic majority categories in 2010, and the nodes on the right represent the categories in 2020. The size of the node shows the size of the category. The arc represents the change as a flow between groups from 2010 to 2020, and the size of the arc represents the size of the flow between the 2010 to 2020 groups.

Exhibit 3

Sankey Chart Showing Change in Racial and Ethnic Categories and Threshold by Census Tract in Washington, D.C., 2010–20

Notes: Sankey Chart produced using www.sankeymatic.com. Census tracts with fewer than 100 residents are omitted from the Sankey Chart.
Sources: Census Bureau decennial census data; author's analysis

The number of census tracts with a Black plurality increased from 12 to 20 from 2010 to 2020. Exhibit 2 shows the locations of the census tracts along with their categorization in both periods, but comparing how neighborhoods changed from one categorization in 2010 to another in 2020 is difficult. The Sankey Chart in exhibit 3 has a node with these categories in both periods and uses an adjusted size to show that the number grew or declined between the periods. The width of the arc between two nodes shows the strength of the flow between categories in each period. The Sankey Chart shows that of the 12 Black plurality census tracts in 2010, one became plurality Hispanic,

five became plurality White, and five became majority White in 2020. The other 19 plurality Black census tracts had been plurality Hispanic (1), majority Black (13), and super majority Black (5).

Plurality White census tracts is the category that grew the largest, increasing from 7 in 2010 to 19 in 2020, with only 4 census tracts in that category in both periods. The total number of super majority Black or White census tracts declined from 2010 to 2020, with most becoming majority Black or majority White. Although these neighborhood changes are visible in exhibit 2, unlike the Sankey Chart, the maps do not neatly show how neighborhoods were changing from one categorization to the next.

A Sankey Chart is a powerful tool for visualizing racial and ethnic neighborhood change. The size of the nodes allows the chart reader to understand how they changed over time, and the size of each arc shows the reader how the groups shifted between those points in time. In this example, the Sankey Chart helps show how the number of census tracts where Black Washingtonians are the largest racial and ethnic group decreased and the number of census tracts where White Washingtonians are the largest racial and ethnic group increased. The Sankey Chart also shows that the number of census tracts where the largest group has a plurality increased, and census tracts with a super majority of Black or White residents decreased.

Appendix

Section 508 of the Rehabilitation Act requires the federal government, including HUD, to make electronic content, such as websites and documents, accessible to individuals with disabilities. HUD recognizes that, although maps and other data visualizations can powerfully convey relationships to policymakers and the public, doing so has inherent accessibility challenges. The purpose of the exhibits in this appendix is to further expand on the description of the Sankey Chart in exhibit 3. Exhibit 4 shows Washington, D.C.'s population by race and ethnicity for each decennial census between 1920 and 2020.

Exhibit 4

Population by Race and Ethnicity in Washington, D.C., 1920–2020

Year	Total	White	Non-White	Black	Hispanic	American Indian and Alaskan Native	Asian and Pacific Islander	Other
1920	437,571	326,860	110,711	-	-	-	-	-
1930	486,869	353,914	132,955	-	-	-	-	-
1940	663,091	474,326	188,765	-	-	-	-	-
1950	802,178	517,865	284,313	-	-	-	-	-
1960	763,956	345,263	418,693	-	-	-	-	-
1970	756,510	209,272	-	537,712	-	956	8,570	-
1980	638,333	166,803	-	444,808	17,777	954	6,415	1,576
1990	606,900	166,131	-	395,213	32,710	1,252	10,734	860
2000	572,059	162,383	-	345,958	44,953	1,303	15,792	1,670
2010	601,723	214,367	-	308,315	54,749	1,337	21,504	1,451
2020	689,545	276,488	-	296,231	77,652	1,318	34,103	3,753

Sources: Census Bureau decennial census data; author's analysis

The total number of census tracts in this analysis is 206 because census tracts with fewer than 100 residents in 2010 were omitted. Exhibit 5 shows the number of census tracts falling within each category in 2010 and 2020. Exhibits 6 and 7 detail the respective sums for 2010 and 2020.

Exhibit 5

Number of Census Tracts by Racial and Ethnic and Threshold Categories in Washington, D.C., in 2010 and 2020

Year			2020								
	Racial/ Ethnic Group		Black			Hispanic			White		
		Threshold	Plurality	Majority	Super Majority	Plurality	Majority	Super Majority	Plurality	Majority	Super Majority
2010	Black	Plurality	1	0	0	1	0	0	5	5	0
		Majority	13	4	0	0	0	0	6	5	0
		Super Majority	5	16	56	0	0	0	2	0	0
	Hispanic	Plurality	1	0	0	1	0	0	1	0	0
		Majority	0	0	0	1	0	0	0	0	0
		Super Majority	0	0	0	0	0	0	0	0	0
	White	Plurality	0	1	0	0	0	0	4	2	0
		Majority	0	0	0	0	0	0	1	17	2
		Super Majority	0	0	0	1	0	0	0	17	38

Sources: Census Bureau decennial census data; author's analysis

Exhibit 6

Number of Census Tracts by Racial, Ethnic, and Threshold Categories in Washington, D.C., in 2010

| | **2010** | | | | |
	Plurality	**Majority**	**Super Majority**	**Total**	**Share**
Black	12	28	79	119	57.8%
Hispanic	3	1	0	4	1.9%
White	7	20	56	83	40.3%
Total	22	49	135		
Share	10.7%	23.8%	65.5%		

Sources: Census Bureau decennial census data; author's analysis

Exhibit 7

Number of Census Tracts by Racial, Ethnic, and Threshold Categories in Washington, D.C., in 2020

| | **2020** | | | | |
	Plurality	**Majority**	**Super Majority**	**Total**	**Share**
Black	20	21	56	97	47.1%
Hispanic	4	0	0	4	1.9%
White	19	46	40	105	51.0%
Total	43	67	96		
Share	20.9%	32.5%	46.6%		

Source: Census Bureau decennial census data; author's analysis

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Alexander Din is a social science analyst in the Office of Policy Development and Research at the U.S. Department of Housing and Urban Development.

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