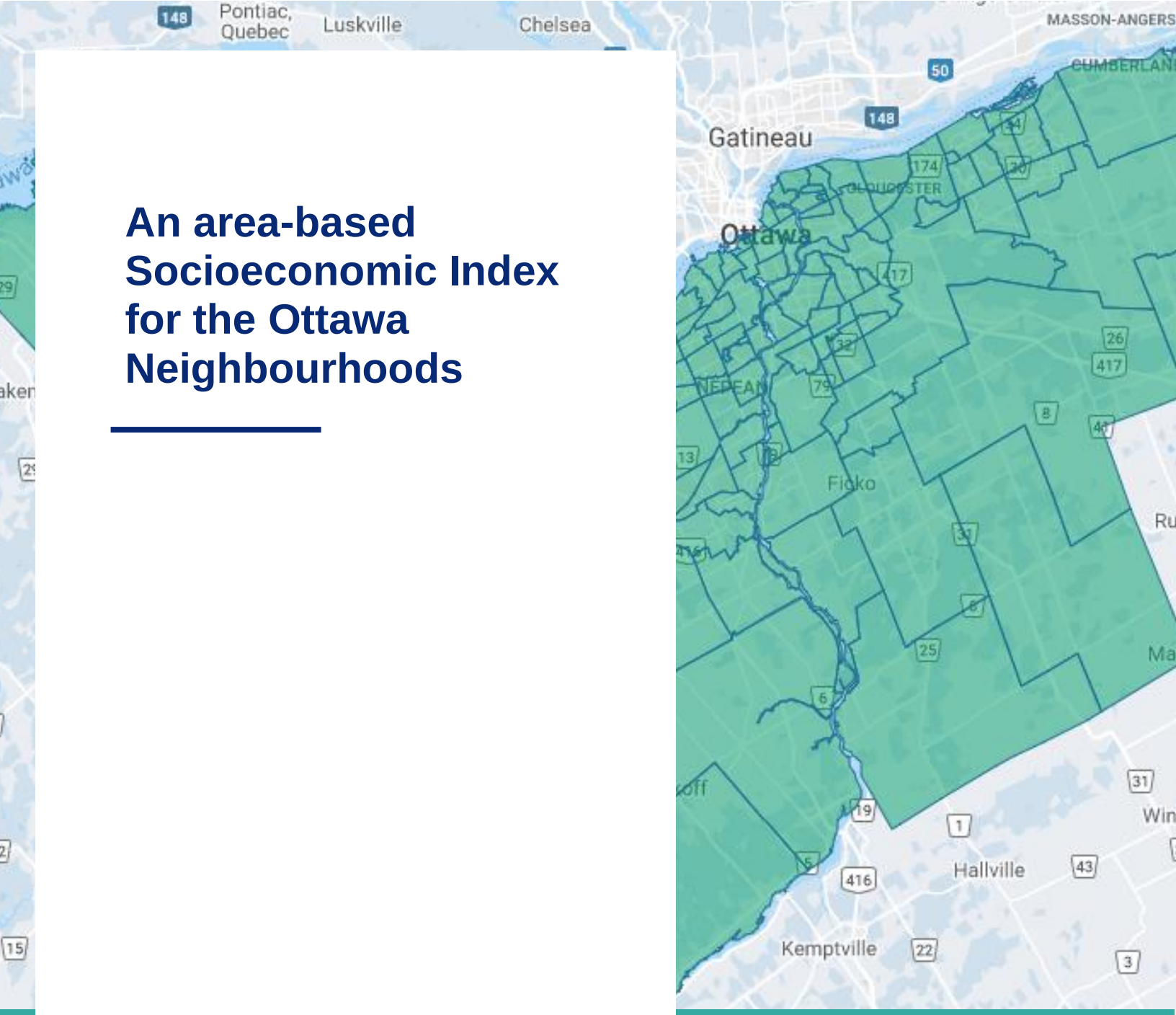

An area-based Socioeconomic Index for the Ottawa Neighbourhoods

21 April, 2020

Authored by:
Kaitlyn Carr,
Dr. Elizabeth Kristjansson,
Ottawa Neighbourhood Study
University of Ottawa

OTTAWA NEIGHBOURHOOD STUDY
ÉTUDE DE QUARTIERS D'OTTAWA

Contents

1 Introduction

1.1 Background

The fact that health is unevenly (and in many cases, unfairly) distributed by socioeconomic status has been well known for many years (Adler, 2002; Shea, 2015; Whitehead, 1991). People who are wealthier tend to live longer and healthier lives than those who are less wealthy (Whitehead, 1991). There is a gradient of effect such that health improves as income and other indicators of socioeconomic advantage increase (CDC, 2019: Kawachi, Subramanian and Almeida-Filho, 2002). These health inequalities exist across most diseases and conditions. Socio-economic differences in health and in resources for health exist between countries, regions and neighbourhoods as well as between individuals.

Understanding the relationships between neighbourhood socioeconomic status (SES), other social determinants of health, and the well-being of residents in neighbourhoods is critical for community members and decision makers who need to identify neighbourhoods that could benefit from more resources. SES inequalities are also being assessed in relation to environmental pollution in Canada (Chan, Serrano, Chen, Stieb, Jerrett, & Osornio-Vargas, 2015).

According to Chan, Serrano, Chen, et al. (2015), “measuring SES using a single indicator, is unlikely to completely reflect its complete complexity” (p. 1). Traditionally, SES has been measured using income, education and occupation. These different components each represent different resources and different aspects of policy (Adler, 2002).

1.2 The Ottawa Neighbourhood Study (ONS) socioeconomic measures

The Ottawa Neighbourhood Study (ONS) first constructed an SES index in 2008 using data from Statistics Canada's 2006 Census to summarize related aspects of neighbourhood socioeconomic disadvantage. This helped to highlight potential socioeconomic differences in health and in opportunities in health. The indicators were selected based on their relationships with health outcomes as well as a review of other indices, including Pampalon's Index of Material and Social Deprivation, a 2-component index which is arguably the most used Canadian area-based index of Deprivation (Chan et al, 2015). ONS, in partnership with Ottawa Public Health (OPH) created a second index in 2015, using data from Statistics Canada's 2011 Census and National Household Survey. These indices, which were analysed at a neighbourhood level, have since been used by local planners and public health workers to readily identify areas with populations of higher vulnerability and risk to adverse social and health outcomes.

In 2019, ONS created a third SES index using data from the 2016 census. This index was created for the National Capital Commission (NCC) to help to identify areas of higher risk for vulnerable populations, where resource allocation can be prioritized as part of their Sustainable Development Strategy (2018-2023). The index was analyzed for the entire National Capital Region (NCR) at a dissemination area (DA) level. In doing this, we revisited key indicators in the literature and consulted key stakeholders and research experts. The indicators selected for the DA-level analysis were used for the new neighbourhood SES index (2020), with some modifications to better fit the neighbourhood model.

2 Methodology

2.1 DA-Level Analysis (2019)

2.1.1 Data Extraction

Candidate variables (n = 39) were extracted from Statistics Canada's 2016 Census for the 1944 dissemination areas (DA's) identified by the NCC as representing the National Capital Region (**see figure 1**). A dissemination area (DA) is the "smallest standard geographic area for which all census data are disseminated" (Statistics Canada, 2019). Variables were selected based on a literature review of socioeconomic indices, deprivation indices, and studies relating to the determinants of heath and socioeconomic inequities in Canada and the United States. In addition, variables were recommended as candidates from research partners at the University of Ottawa, Ottawa Public Health, and the Champlain Local Health Integration Network (LHIN).

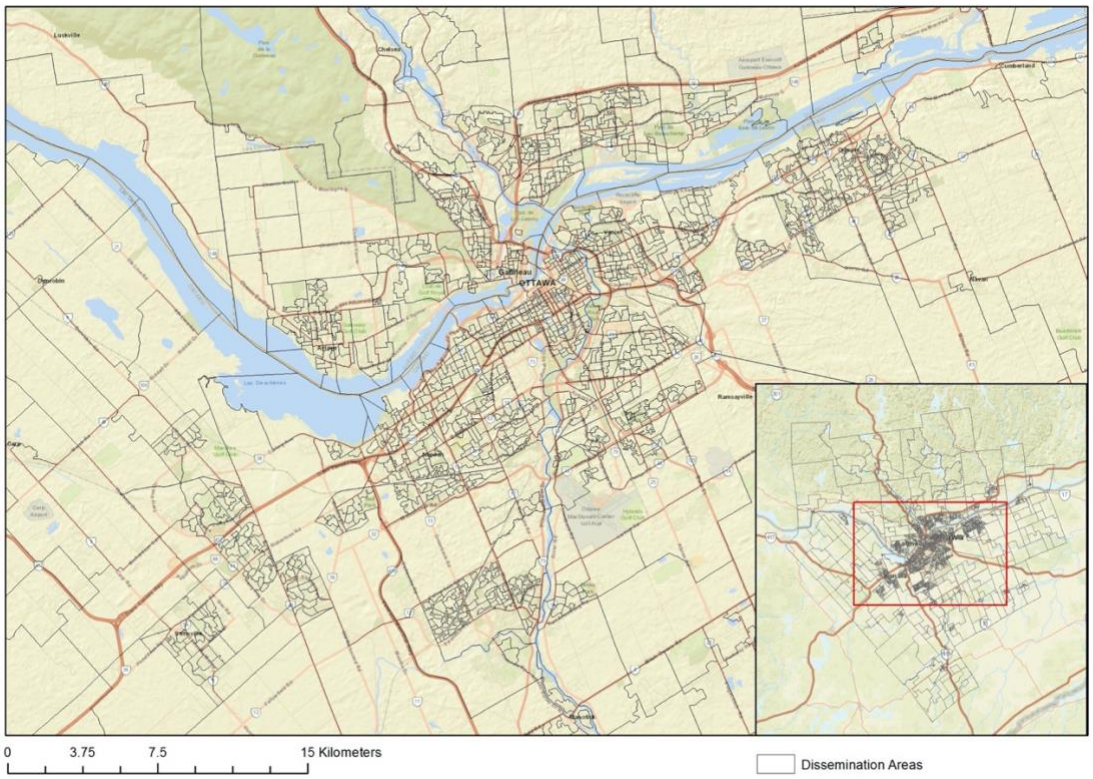

Figure 1. Dissemination Areas (DA's) representing the National Capital Region (NCR). Base Map: World Street Map, ESRI.

Candidate variables (**see full list in Appendix A**) were grouped by categories (**see Table 1**): Education & Employment (n=5), Family/Household (n=3), Social (n=6), Housing (n=7), Income (n=12), and Cultural (n=6). Variables were transformed into population measures using population and household totals from the 2016 Statistics Canada Census.

Category	Variables from 2016 Census
Education & Employment	n=5
Family / Household	n=3
Social	n=6
Housing	n=7
Income	n=12
Cultural	n=6

Table 1. Categories of candidate variables where n represents the number of candidate variables from each respective category.

2.1.2 Variable Selection and Processing

Collinearity. A correlation matrix was produced for all candidate variables to assess collinearity among variables. Collinear candidate variables were flagged and respectively grouped to assure that only one candidate variable would be selected from each collinear group.

Transformations and variable groupings. Variables were assessed for normality, skewedness, and kurtosis, and were transformed accordingly. In order to arrive at a proxy measure for core housing need, three variables were averaged (arithmetic mean) and represented as percentage of households in each DA: unaffordable housing, unsuitable housing, and inadequate housing).

Consultations and preliminary analyses. An iterative consultation took place throughout the variable selection and Principal Component Analysis (PCA) interpretation process to benefit from the expertise and guidance from key research partners (including the Champlain LHIN and Ottawa Public Health). Research partners advised against including cultural variables and suggested a focus on economic indicators. Other variables were dropped from the analysis on the basis of contributing

too little to the principal component, or displaying collinearity with other key variables during the preliminary analyses.

Final variable selection. After multiple analyses and interpretations, a final selection of seven variables was made: (1) residents living in low income according to the low-income measure after taxes (LIM-AT), (2) participation rate, (3) lone-parent families, (4) unemployment rate, (5) residents aged 25-64 with no high school diploma, (6) median market income before taxes, and (7) core housing need (averaged rate of unaffordable, unsuitable, and inadequate housing). **See Appendix B** for choropleth maps representing each of the seven variables (before transformations).

Data Analysis. A PCA was conducted to arrive at the seven-indicator component of socioeconomic status. The PCA was run (with no rotation) and extracted based on Eigenvalues greater than 1, a visual inspection of the scree plot, and a 4:1 ratio of the first to the second eigenvalue[1]. Index scores were transformed to deciles each representing 10% of DAs, with "decile 1" representing the lowest scores (least disadvantaged) and "decile 10" representing the highest scores (most disadvantaged).

[1] If the ratio of the 1st to 2nd eigenvalue is 3:1 or greater, researchers often interpret this as showing the presence of one strong component or factor.

2.2 Neighbourhood-Level Analysis (2020)

2.2.1 Data Extraction

The nine 2016 Statistics Canada Census of Population variables used in DA-Level analysis (6, plus the three used for core housing need) were obtained at the neighbourhood level through the Ottawa Community Data Consortium (Community Data Program of the Canadian Council on Social Development).

	Variable	Definition
1	Residents below LIM-AT	Percentage of residents living in low income according to the low-income measure after taxes (LIM-AT)
2	Participation rate	Percentage of residents aged 15 years and older who are in the labour force (whether employed or unemployed)
3	Lone-parent families	Percentage of census-family-households with a lone-parent
4	Unemployment rate	Percentage of residents aged 15 years and older who are in the labour force and unemployed
5	No high school diploma	Percentage of residents aged between 25-64 with no high school diploma, certificate or degree
6	Median market income	Market income is defined as the total income (from employment, investments, retirement savings, and all other market sources), minus government transfers (before taxes)
7	Unaffordable housing	Percentage of tenant households spending 30% or more of total before-tax income on shelter costs
8	Unsuitable housing	Percentage of households with an unsuitable number of bedrooms for the size and composition of the household, according to the National Occupancy Standard (NOS) requirements
9	Inadequate housing	Percentage of households whose housing requires major repairs (defective plumbing or electrical wiring, or structural repairs to walls, floors or ceilings are required)

Table 2. Candidate variables for the neighbourhood-level SES analysis and their definitions.

Neighbourhoods with population sizes smaller than 1,000 were excluded from the analysis. Most of these neighbourhoods had very insignificant population sizes and were industrial areas of Ottawa. The following seven neighbourhoods were excluded:

- Beechwood Cemetery
- Carleton University
- Hunt Club South Industrial
- Lebreton Development
- Notre-Dame Cemetery
- Orleans Industrial
- Watering Village

In addition to the seven excluded neighbourhoods, the Greenbelt was suppressed due to its small population size and large area covering (not appropriate for an area-based analysis). This left a sample size of n=103 for the PCA analysis.

2.1.2 Variable Transformations

Normality was assessed for each of the variables based on their skewness and kurtosis, in conjunction with observations from a Shapiro-Wilk test of normality (See **Appendix A**).

The table below summarizes the transformations that were performed on each variable to achieve normality. Unaffordable housing was removed from the analysis due to its distribution (heavy skew and kurtosis) despite transformations, as well as its interpretation at the neighbourhood level. When observing the percent of residents with unaffordable housing at the neighbourhood level, the data seemed to (generally) be more representative of neighbourhoods with high cost of housing than of neighbourhoods with vulnerable populations. This left us with eight final variables for the PCA.

	Variable	**Transformation**
1	Residents below LIM-AT	Square root
2	Participation rate	Third power
3	Lone-parent families	Square root
4	Unemployment rate	Square root
5	No high school diploma	Square root
6	Median market income	Square root
7	Unaffordable housing	NA **(variable removed)**
8	Unsuitable housing	Square root
9	Inadequate housing	NA (no transformations necessary)

Table 3. Variables used in analysis and transformations applied to obtain normal or close-to-normal univariate distributions. Note: unaffordable housing was removed from analysis.

3 Results

3.1 Principal Component Analysis Results

We ran a PCA on the eight final indicators, with no rotation and extracted based on Eigenvalues greater than 1 and a visual inspection of the scree plot. A Kaiser-Meyer-Olkin (KMO) value of .864 was obtained, indicating adequate sampling. Bartlett's Test of Sphericity was significant (.000), indicating that the variables are not orthogonal. The index scores derived from the PCA of the eight final variables had a fairly normal distribution (mean = 0.00, median =-0.308, SD = 1.00). The first component was extracted with a retained variance of 65.3%. Of the two components extracted, the ratio of Eigenvalues from the first to second was almost 5:1 (see **Appendix A**).

The index is the result of a PCA of the final eight transformed variables derived from the 2016 Statistics Canada census: (1) lone-parent families, (2) participation rate, (3) unemployment rate, (4) residents aged 25 to 64 with no high school diploma, (5) median market income, (6) residents living in low income (LIM-AT), (7) households with unsuitable housing, and (8) households with inadequate housing.
Factor scores from the index were converted to quintile scores, with 21 neighbourhoods falling into quintile "1" (most advantaged), 21 in quintile "2", 20 in quintile "3", 20 in quintile "4", and 21 in quintile "5" (most disadvantaged).

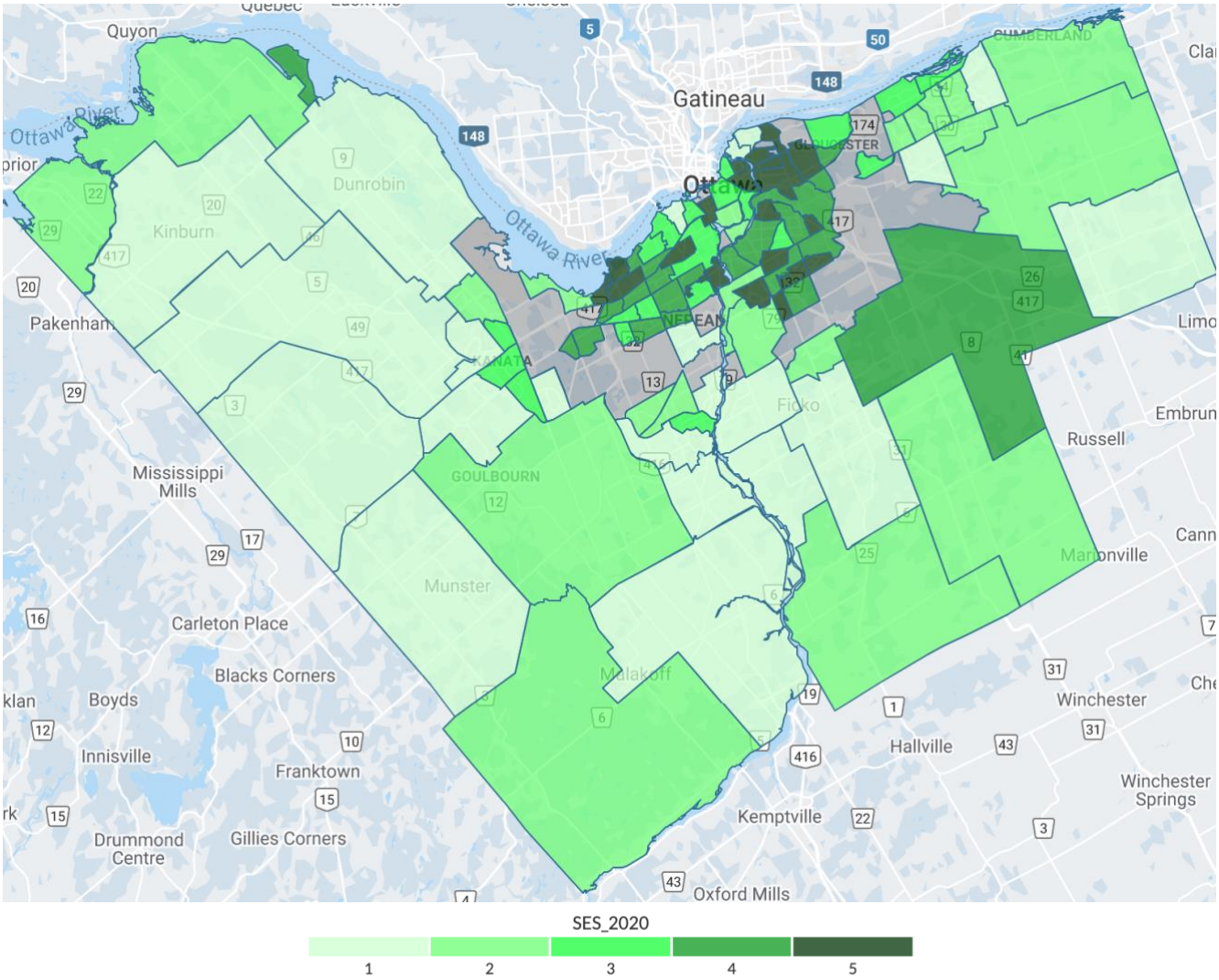

Figure 2. Final SES index represented as quintiles for neighbourhoods in Ottawa. A score of "5" (darkest shade) indicates a neighbourhood in the quintile of highest socioeconomic disadvantage, and a score of "1" (lightest shade) indicates a neighbourhood in the quintile of least disadvantage. Grey: no data.

4 Conclusion

4.1 Limitations

According to Pampalon et. al, it is important to note that “the literature shows that measures of deprivation perform differently in urban and rural settings” (Pampalon, Hamel, Gamache, & Raymond, 2009). It may be advantageous to compare rural neighbourhoods against other rural neighbourhoods rather than against all Ottawa neighbourhoods.

It is also worth noting that the Census reports only on the population in private households, and does not include the population living in institutional collective dwellings such as hospitals, nursing homes, or prisons (Statistics Canada, 2016).

4.2 Remarks

We have created this index in hopes that it will serve as a tool for identifying populations living in disadvantaged socioeconomic situations with higher risks of adverse social and health outcomes. We hope that it can be used in other municipalities or provinces across Canada.

References

Adler, N. and Newman (2002). Socioeconomic Disparities in Health: Pathways and Policies. Health Affairs, 21, 2.

Chan, E., Serrano, J., Chen, L, Steib, D.M., Jerret, M. and Osornio-Vargas, A. (2015). Development of a Canadian socioeconomic status index for the study of health outcomes related to environmental pollution BMC Public Health (2015) 15:714.

Centres for Disease Control and Prevention "Definitions' https://www.cdc.gov/nchhstp/socialdeterminants/definitions.html. Downloaded on April 2, 2019

Pampalon, R., Hamel, D., Gamache, P., Philibert, M. D., Raymond, G., & Simpson, A., (2012). An area-based material and social deprivation index for public health in Québec and Canada. Canadian Journal of Public Health, 103, S17-S22A. Retrieved from https://search.proquest.com/docview/1269153597?accountid=14701

Pampalon, R., Hamel, D., Gamache, P., & Raymond, G. (2009, October 4). A deprivation index for health planning in Canada. *Health Promotion and Chronic Disease Prevention in Canada, 29*(4).

Statistics Canada (2019). Dissemination Area Boundary Files (catalogue no. 92-169-X). Retrieved March 17th, 2019 from: https://www150.statcan.gc.ca/n1/en/catalogue/92-169-X.

Statistics Canada (2016). Dictionary, Census of Population (catalogue no. 98-301-X2016001). Retrieved March 17th, 2019 from: https://www12.statcan.gc.ca/census-recensement/2016/ref/dict/98-301-x2016001-eng.pdf.

Appendix A

		unsuitable_housing	major_repairs	unaffordable_housing_tenant	LIM_AT	unemployment	no_diploma	lone_parent	median_market_income	participation_rate
N	Valid	104	104	104	104	104	104	104	104	104
	Missing	0	0	0	0	0	0	0	0	0
Mean		4.4316	5.499	40.342	12.563	7.365	6.560	16.221	42281.69	66.323
Median		3.7150	5.365	40.500	9.000	6.650	5.400	15.450	42408.00	66.700
Std. Deviation		3.38573	2.5834	9.4929	9.1744	2.4350	3.8168	6.1463	9614.698	6.4914
Skewness		2.332	.327	-2.011	1.285	.849	1.259	.620	.620	-.677
Std. Error of Skewness		.237	.237	.237	.237	.237	.237	.237	.237	.237
Kurtosis		7.186	-.166	7.761	.937	.389	1.573	-.101	2.382	1.580
Std. Error of Kurtosis		.469	.469	.469	.469	.469	.469	.469	.469	.469

Figure A-1. Descriptive statistics of the nine candidate variables. A skewness that is less than -1 or greater than 1 indicates a highly skewed distribution. A kurtosis of between -2 to +2 is considered acceptable to prove a normal distribution.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
unsuitable_housing	.181	104	.000	.785	104	.000
major_repairs	.054	104	.200*	.986	104	.329
unaffordable_housing_tenant	.155	104	.000	.824	104	.000
LIM_AT	.171	104	.000	.847	104	.000
unemployment	.123	104	.001	.945	104	.000
no_diploma	.161	104	.000	.899	104	.000
lone_parent	.081	104	.089	.961	104	.004
median_market_income	.048	104	.200*	.968	104	.012
participation_rate	.048	104	.200*	.959	104	.003

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure A-2. Normality test for the nine candidate variables. A Shapiro-Wilk significance >0.05 indicates a normal distribution.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.864
Bartlett's Test of Sphericity	Approx. Chi-Square	690.987
	df	28
	Sig.	.000

Figure A-3. Results from KMO and Bartlett's Test. KMO test shows adequate sampling (KMO .864) and Barltlett's Test of Sphericity has a good significance (.000), indicating that variables are not orthogonal.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.226	65.322	65.322	5.226	65.322	65.322
2	1.074	13.420	78.742	1.074	13.420	78.742
3	.596	7.449	86.190			
4	.443	5.541	91.731			
5	.234	2.930	94.661			
6	.168	2.102	96.763			
7	.146	1.822	98.585			
8	.113	1.415	100.000			

Extraction Method: Principal Component Analysis.

Figure A-4. Over 65% of the total variance was explained by the first component. The Eigenvalue ratio from the first component to the second was approximately 4.9:1.

Category	Variables (2016 Census)
Education & Employment	No high school diploma (aged 15+) No high school diploma (aged 25-64) Individuals with a post-secondary (aged 25-64) Higher education - masters/PhD (aged 25-64) Unemployment rate (aged 15+)
Family / Household	Lone-parent families Lone-parent families with 2+ children Multiple-family household
Social	Single-person household / living alone Seniors (aged 65+) Dependents (aged under 20) Not in the labour force Separated, divorced, or widowed Participation Rate
Housing	Tenure: Renters More than one person per room Spending 30% + on shelter costs Not suitable housing Major repairs needed % Tenants in subsidized housing Core Housing Need (average rate)
Income	Low income measure after taxes (LIMAT) Median Resident Income (AT) Median Market Income (BT) Median Government Transfers Median Employment income % income from government transfers Median Household Income (AT) Median Income for economic families (AT) Average AT income for residents Average market income for residents Average employment income for residents Average AT income for economic families
Cultural	Aboriginal Identity Recent immigration (2011-2016) 10-year immigration (2006-2016) Knowledge of neither English nor French Refugees Visible Minority

Table A-1. Full list of original candidate variables for SES index which were narrowed down during the DA-level analysis (from 2016 Statistics Canada Census).

Appendix B

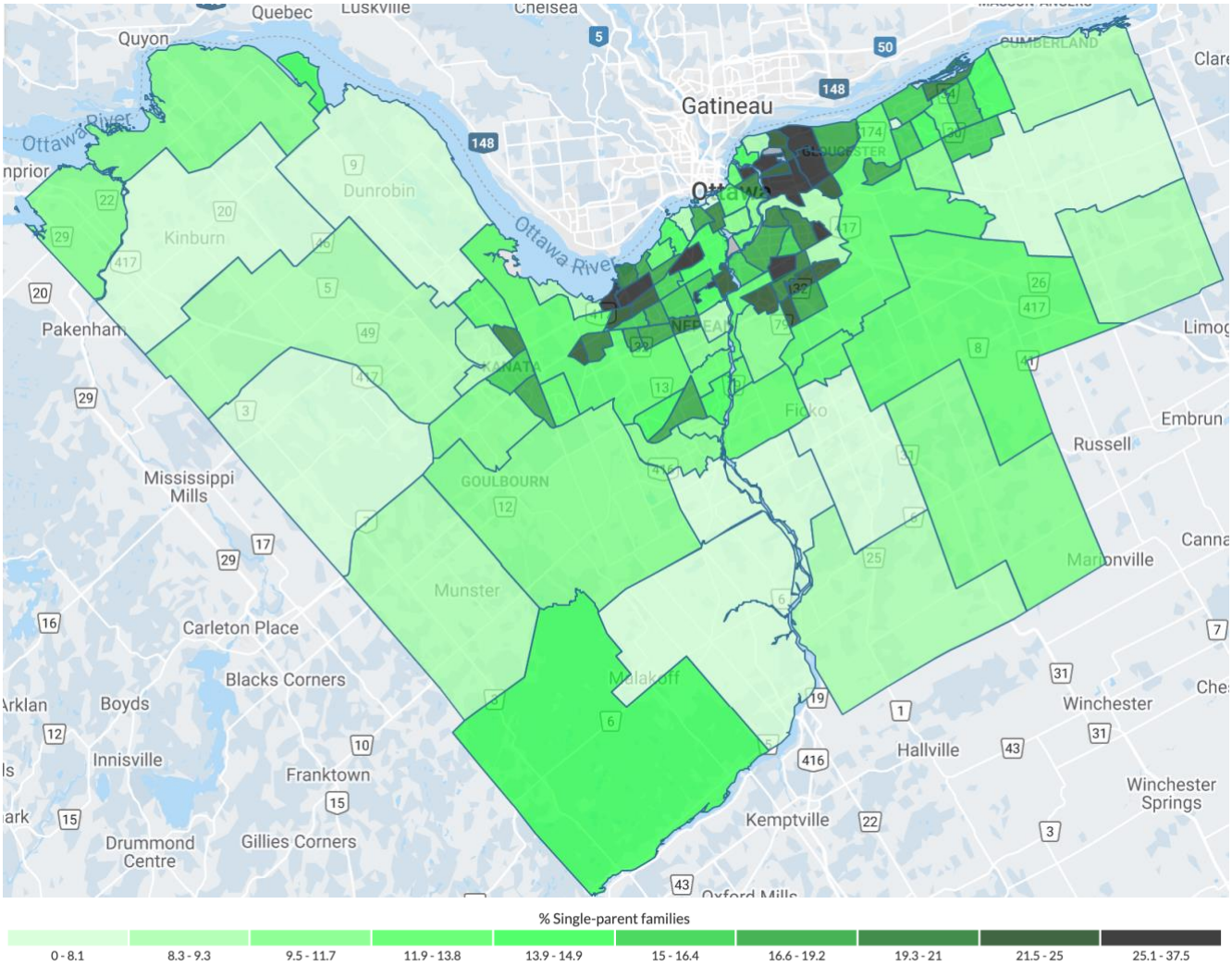

Figure B-1. Percent of census families that are lone-parent families for Ottawa neighbourhoods (Statistics Canada, 2016). Grey: no data.

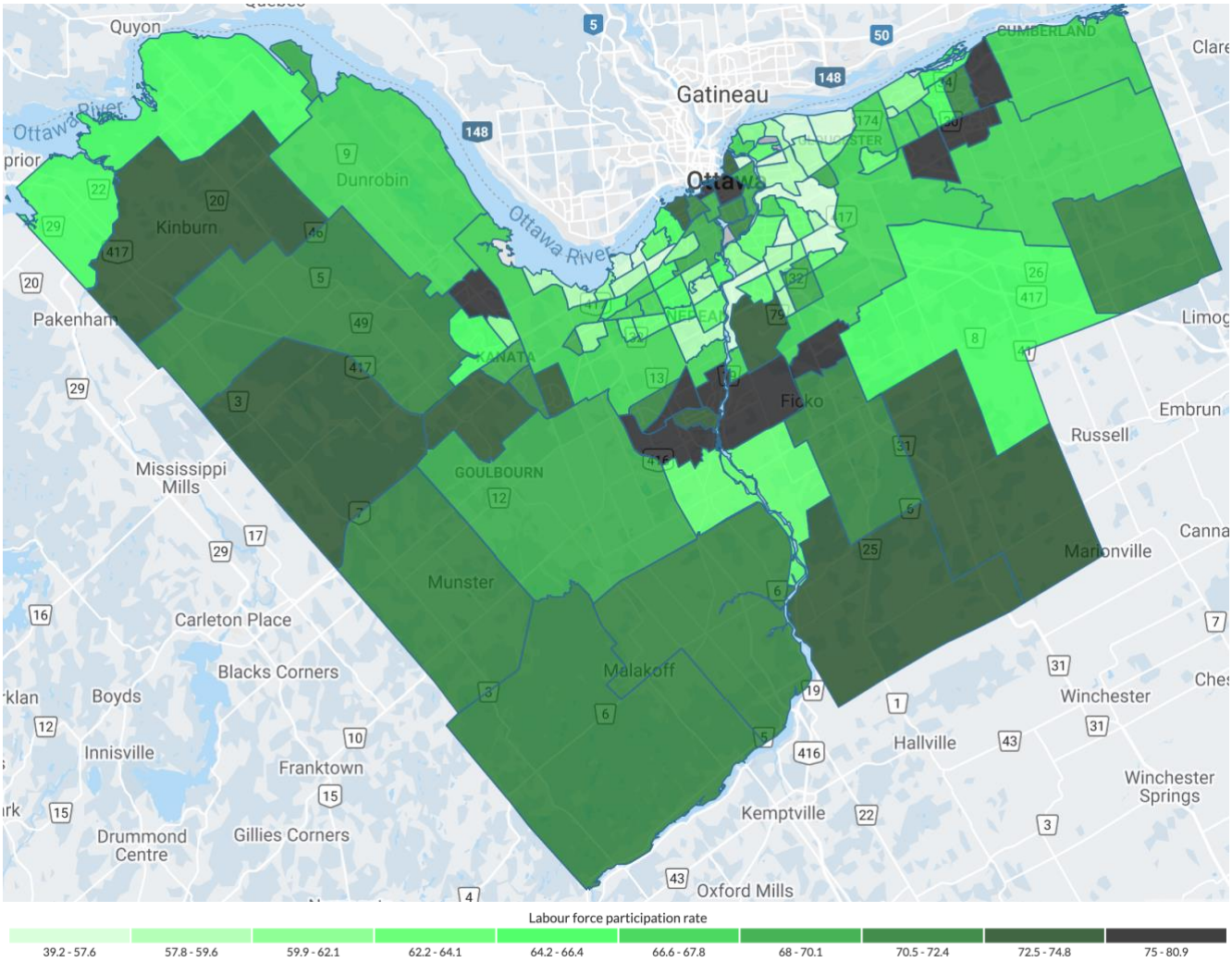

Figure B-2. Participation rate in Ottawa neighbourhoods (those in the labour force, whether employed or unemployed) during the week of Sunday, May 1 to Saturday, May 7, 2016, expressed as a percentage of the population aged 15 years and over living in private households. Grey: no data.

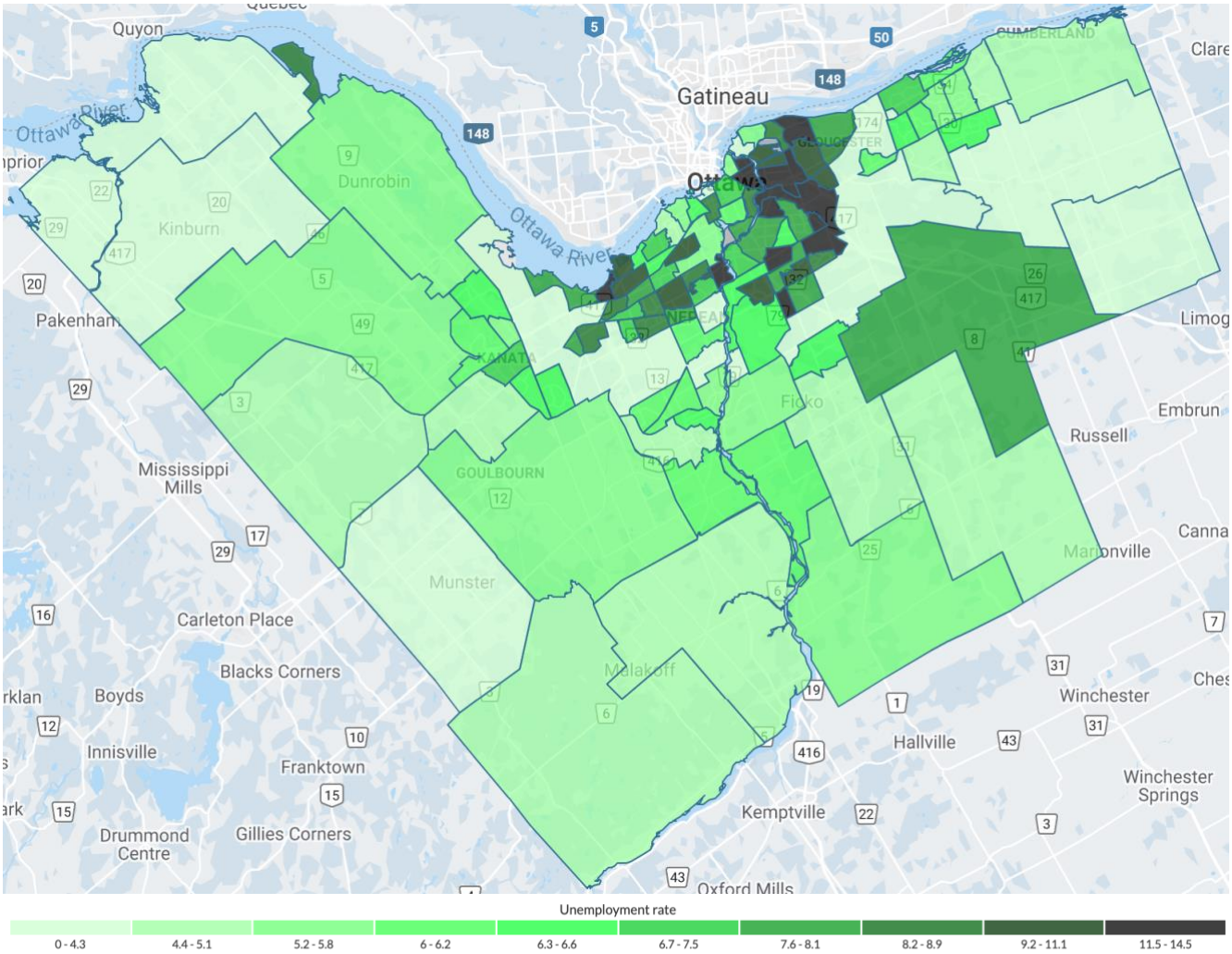

Figure B-3. Unemployment rate in Ottawa neighbourhoods (those who are in the labour force but unemployed), expressed as a percentage of the labour force in the week of Sunday, May 1 to Saturday, May 7, 2016. Reported for the population aged 15 years and over in private households (Statistics Canada, 2016). Grey: no data.

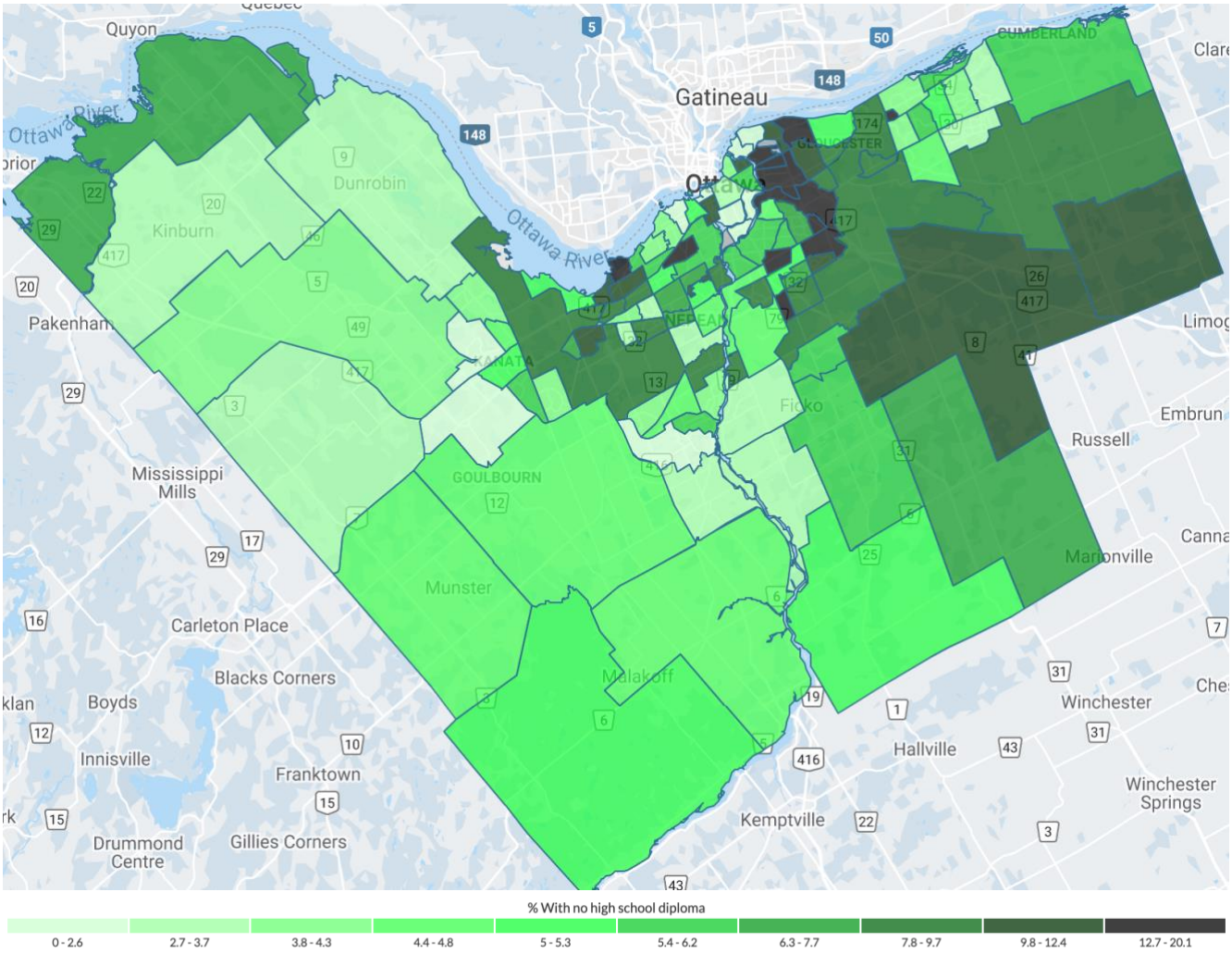

Figure B-4. Percent of residents aged 25 to 64 in private households in Ottawa neighbourhoods who have not obtained a secondary school or high school diploma, graduation certificate, or equivalency certificate (have no certificate, diploma or degree) (Statistics Canada, 2016). Grey: no data.

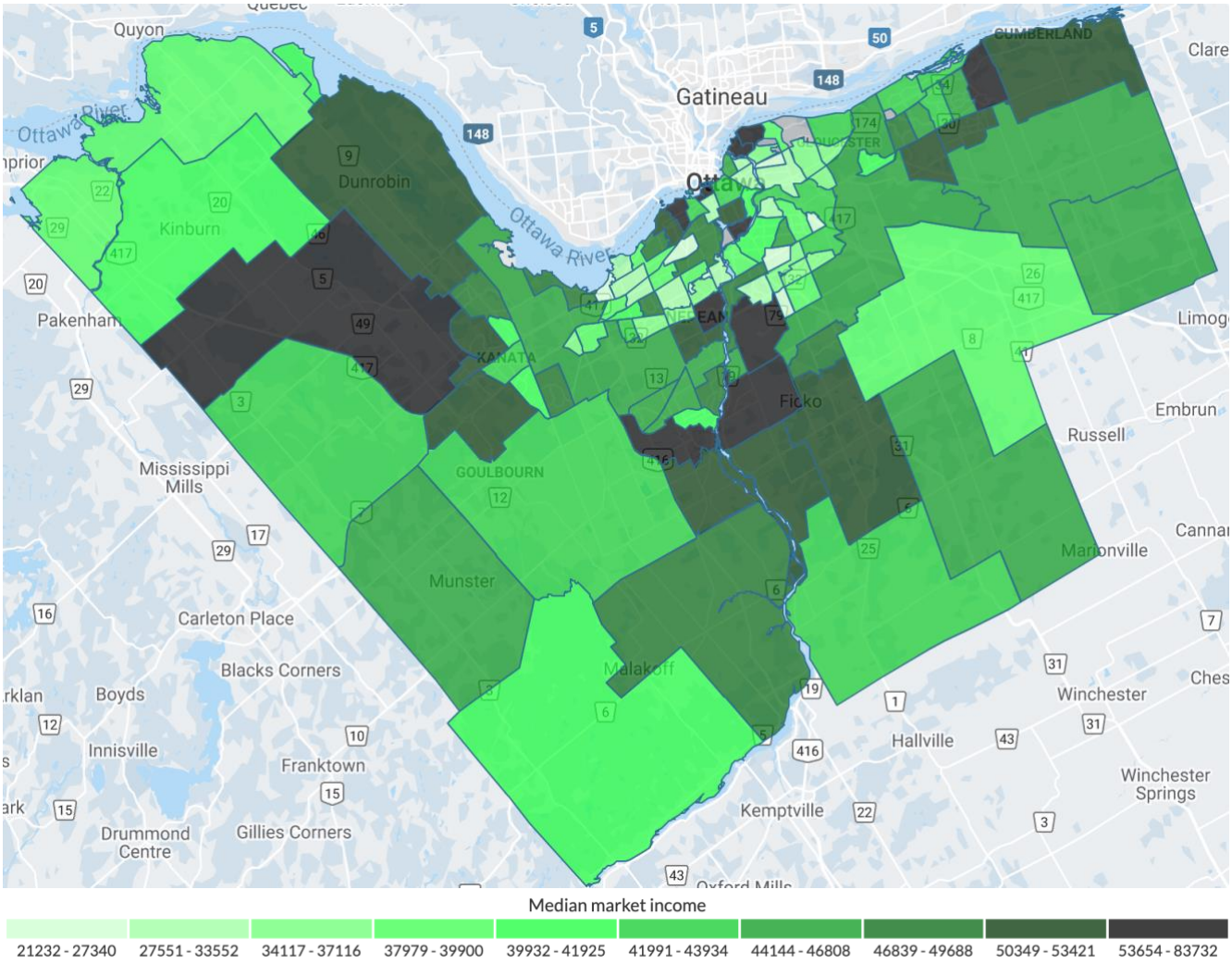

Figure B-5. Median market income for neighbourhoods in Ottawa, expressed in Canadian dollars. Market income refers to the total income minus government transfers, before transfers and taxes, for residents aged 15 years and over in private households. The reference period is the calendar year 2015 (Statistics Canada, 2016).

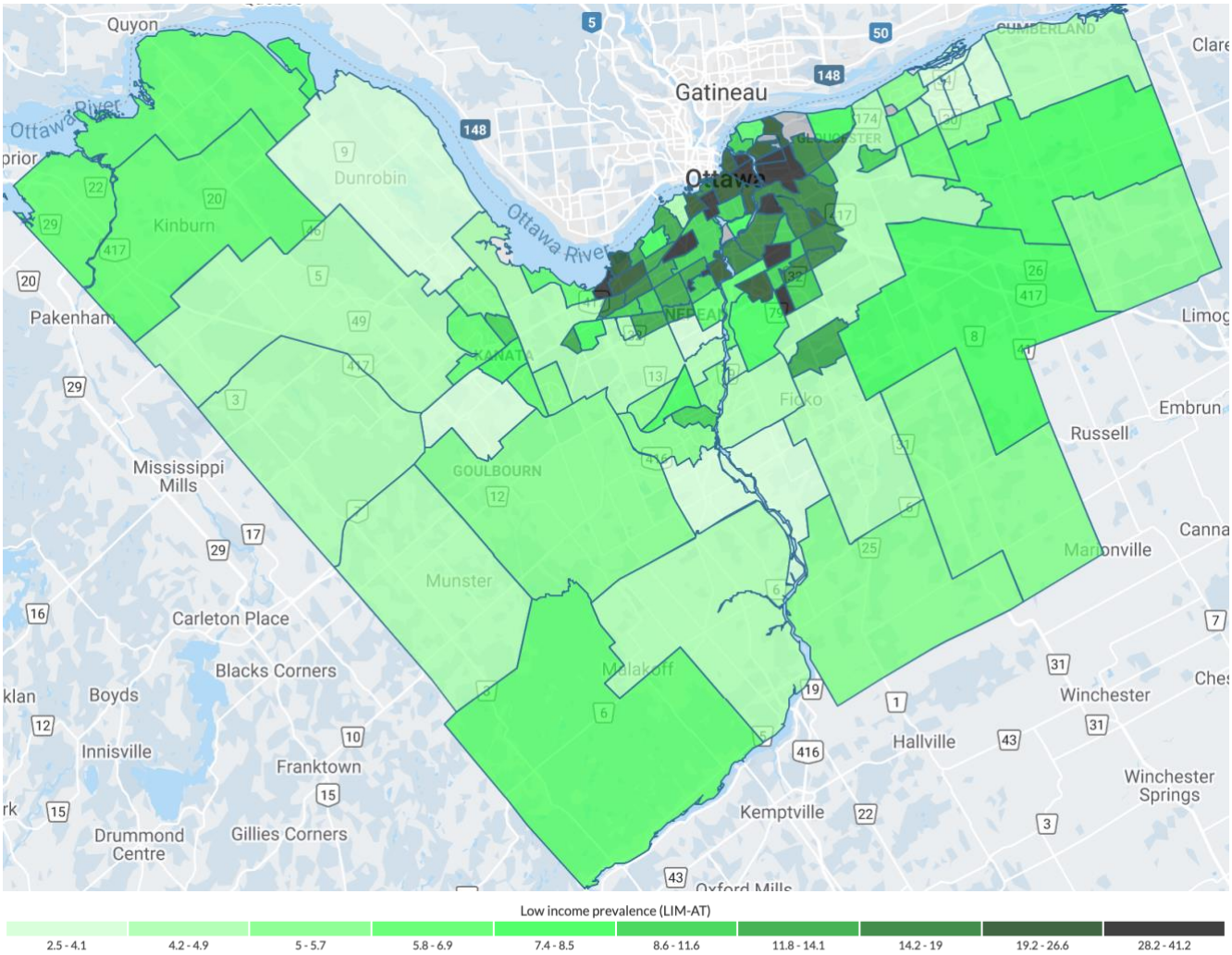

Figure B-6. Percent of residents living in low income in Ottawa neighbourhoods, according to the low-income measure, after tax (LIM-AT). The LIM-AT refers to a fixed percentage (50%) of median adjusted after-tax income of private households. The household after-tax income is adjusted by an equivalence scale to take economies of scale into account. This adjustment for different household sizes reflects the fact that a household's needs increase, but at a decreasing rate, as the number of members increases. This is reported for residents living in private households where low-income concepts are applicable (Statistics Canada, 2016). Grey: no data.

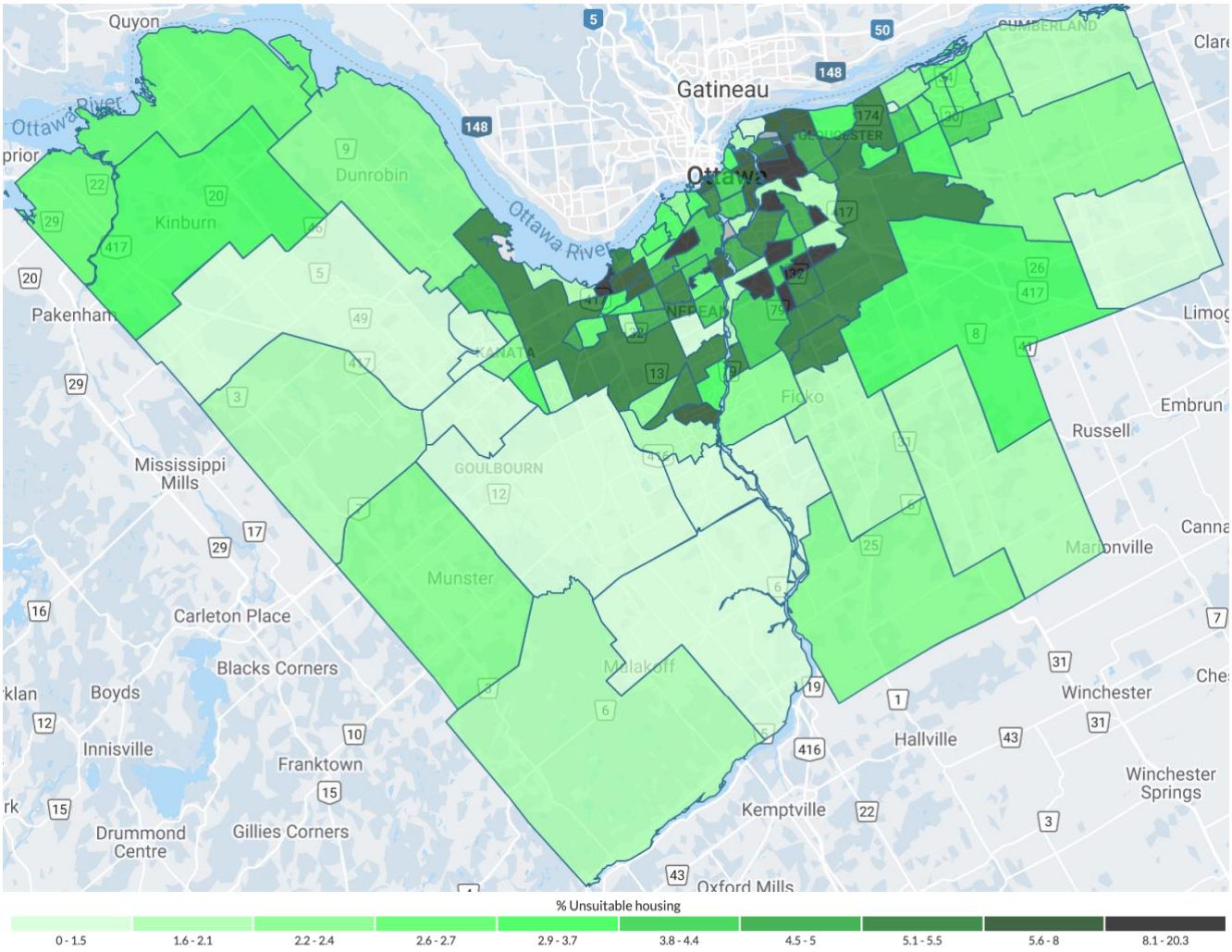

Figure B-7. "Unsuitable housing" rate (%) for neighbourhoods in Ottawa. Unsuitable housing refers to private households with an insufficient number of bedrooms for the size and composition of the household, according to National Occupancy Standard (NOS) requirements (Statistics Canada, 2016). Grey: no data.

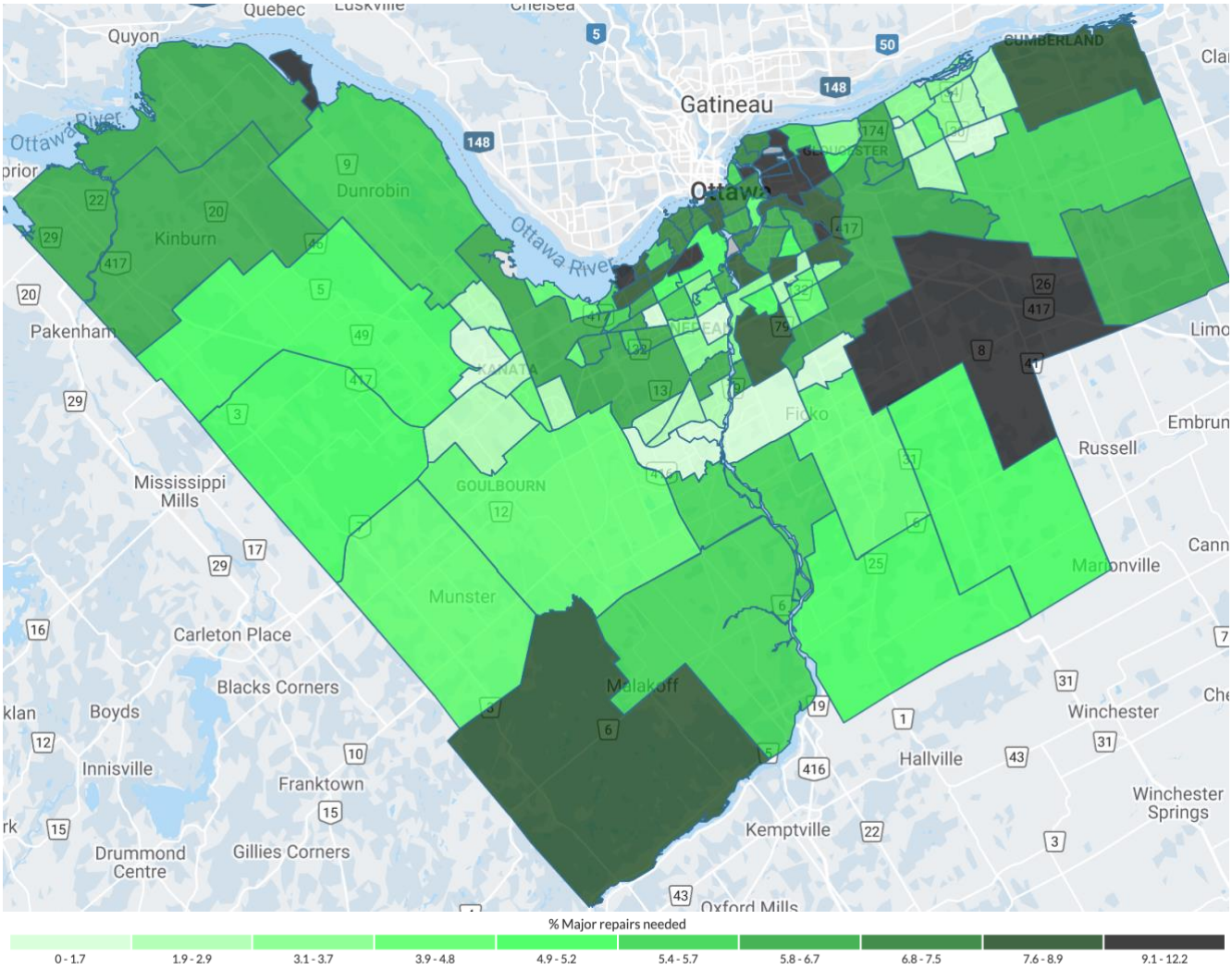

Figure B-8. Inadequate housing rate (%) for Ottawa neighbourhoods. Inadequate housing refers to the percent of households with dwellings that are reported by their residents as needing major repairs (Statistics Canada, 2016). Grey: no data.