A POPULATION DENSITY AND HOUSING - UNIT - LEVEL APPROACH TO CHARACTERIZING URBAN SPRAWL

MONTREAL AND TORONTO - JUST HOW DISSIMILAR ?

TRANSPORTATION AND LAND DEVELOPMENT : URBP 619 : WINTER 2005 : SCHOOL OF URBAN PLANNING : MC GILL UNIVERSITY

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All maps, tables and graphs have been made by the author, using data from CHASS website :- http://www.chass.utoronto.ca, and from Census 2001,'96,'91,'81,'71, Geographic Files.

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Introduction

{ In the 1950s and 1960s, gross urban population density across Canada and America fell quickly and a new phrase**, "urban sprawl",** was coined to describe the phenomenon}.[1] The regions which defined the central regions of these cities greatly expanded and led to a range of development from satellite towns to industrial districts and employment hubs. This was but natural considering the demand for housing, increasing urban/suburban population, availability of cheaper land on the outskirts of the city, and infrastructure - predominantly transport. { However, in the 1970s, 1980s, and 1990s, new development in the form of clustered housing, in-fill, redevelopment, and conversions helped raise densities in parts of some urban regions}. [2]

Urban sprawl is best understood as the result of *urbanization*. As more people move to urban areas, more land is consumed and traffic increases because they bring their cars with them. Urban growth has been substantial in recent decades. {The ten largest Census Metropolitan Areas (CMAs), in Canada have risen from a total population of 8.9 million in 1951 to 19.1 million in 2001, an increase of 115 percent. Housing more than 10 million additional people has meant, in turn, that more urban land has had to be developed}. [3]

{In Canada, where land-use regulation is thought to have been more extensive, it might be argued that population density should therefore now be correspondingly higher}.[4] Virtually, all of the urban growth has been outside the core cities, which were already crowded 50 years ago. {As a consequence, the share of urban area residents living in the core of cities has declined. This reflects the international trend, and has been the source of a common criticism to the effect that suburbs have "drained the cities". But even where core city losses have been sustained, suburban growth has largely been the result of in-migration from rural or smaller urban areas}. [5]

A growing number of studies examine in detail the spatial structure of metropolitan areas of Montreal and Toronto, or present comparisons at the Census Tracts level. Sprawl analysis can be conducted at multiple scales and geographical extents.

This paper compares the spatial structures of the two largest Canadian metropolitan areas: {**Toronto**, (population 4.4 million in 1996, Canada's principal business and financial service centre), and **Montreal** (population 3.4 million, regional centre for high-order services and Canada's principal manufacturing centre) }.[6] This paper is an attempt (within its limitations) to measure and compare sprawl between these two Canadian cities which are governed by different institutions and market forces. Sprawl is seen (in this paper) as a function of *Population density* and *New Housing Constructions.* It looks at how these two variables change with the increasing distance from the CBD's of these two cities thereby exploring the trends, patterns and changes in the spatial patterns of these two cites.

1,2,4. **Urban sprawl in Canada and America: just how dissimilar?**
John R. Miron (Professor of Geography and Planning. University of Toronto at Scarborough)
http://www.citieslab.utsc.utoronto.ca/Papers/UrbanSprawl.pdf

3,5. **"SMART GROWTH": Threatening the Quality of Life ,** Wendell Cox,
AIMS Urban Futures Series, Paper #1. Frontier Centre for Public Policy Series No. 20
www.aims.ca/library/coxfinal.pdf

6. **A tale of four cities: intra-metropolitan employment, distribution in Toronto, Montréal, Vancouver, and Ottawa hull, 1981 - 1996.** Richard Shearmur and William J Coffey.

Objectives and Need of Study

This is a particularly interesting time to study urban structures because cities' growth patterns are undergoing change. For many decades cities have been spreading out. {In the cacophony of voices within the social sciences and city planning literature on the subject, "urban Sprawl" often is an epithet hurled at a pattern or process that an author finds distasteful}.[7]

{A typical person who wants to own a car, a detached house in the suburbs with yard space and clean air, in an environment free from poverty, a quick commute to a low-rise worksite in a park-like setting has resulted in sprawl—"unlimited low density growth" This has raised issues of excessive travel, traffic congestion, air pollution, water and waste disposal problems, and disappearance of open (vacant) space.}[8]

{Proponents of planning innovations through the years—e.g., planned unit development, growth management, transit-supportive development, smart growth, new urbanism, compact cities, and sustainable cities—are each quick to point out how we might cure sprawl by application of their ideas. At the same time, their critics point out the fuzziness in thinking, the rationalizations, and the evident failures in past attempts to "correct" sprawl. Now, perhaps more than ever, scholars, planners, activists, communities, and governments alike, albeit in different ways, express the view that current patterns of urban development create worrisome social, economic and environmental problems.}[9] To clarify this debate, we need a better conceptualization, better definitions and better supporting data. Fortunately, with the proliferation in recent years of massive amounts of geo-referenced small-area data, and the technology to analyze them, we are now able to take a fresh look at the topic of urban sprawl.

{Even though it is not the only way to think about sprawl, population density is at the heart of many of these conceptualizations. Further, much of the debate about sprawl focuses on the extent of variation in density across an urban region. Further, there is a fundamental conflict here in the interpretation of a change in density and its spatial variation. To those who see sprawl as a problem to be solved, an increase in density (a more compact urban region) and a reduction in its variation is often seen to be good. To those who see sprawl as a problem experienced, an increase in density—whether through intensification, in-filling, or reduction in open space—and a reduced variability may well be seen as bad.}[10]

Clark (1951)* used a density gradient model to help understand and predict the variation in population density across the urban region and its changes over time. He used data at the level of Census Tracts for large, growing urban regions in North America, Europe, and Australia from **1801 to 1947** to draw two generalizations: viz :-

1. In every large city, excluding the central business zone, which has few resident inhabitants, we have districts of dense population in the interior, with density falling off progressively as we proceed to the outer suburbs.

2. In most (but not all) cities, as time goes on, density tends to fall in the most populous inner suburbs, and to rise in the outer suburbs, and the whole city tends to 'spread itself out'.

7,8.,9. Urban sprawl in Canada and America: just how dissimilar?
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http://www.citieslab.utsc.utoronto.ca/Papers/UrbanSprawl.pdf

10. SPRAWL AND URBAN GROWTH
Edward L. Glaeser (Harvard University and NBER) and
Matthew E. Kahn. (Tufts University)
http://post.economics.harvard.edu/hier/2003papers/2003list.html

The first generalization suggests the presence of sprawl, in the sense that newer (outer) suburbs are less densely populated than older (inner) suburbs. The second generalization suggests that, with time, low-density suburbs become more densely populated.

Clark explains his results as follows :-

If a metropolitan area is to have a high total population, it must either put up with a considerable degree of overcrowding in the inner suburbs, or it must spread itself out. Spreading out is only possible where transport costs are low in relation to the citizen's income.

{ So, it is the combination of city size and the cost of transportation relative to income that drives the density gradient. Flattening of a city's gradient over time leads to a spreading urban region (sprawl), and the cause is the increasing affluence of households.} [11]

Expanding urban boundaries has also been the case with Canada since cities started to grow. {Toronto and Montreal are no exception to this rule. Canada's two largest cities had fewer than 500,000 inhabitants a century ago; they now have more than five and three million people respectively.} [12] It's only natural that their urbanized areas have grown. In lieu if the above mentioned facts, it then would be of interest to know which of these two cities, both being under great political, real estate pressures and human needs are *sprawling* at a greater rate, and whether these two cities are following Clark's density model today.

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* **Clark, C. 1951. Urban Population Densities.** *Journal of the Royal Statistical Society, Series A, 114*, 490-496.

11. **"SMART GROWTH": Threatening the Quality of Life ,** Wendell Cox, AIMS Urban Futures Series, Paper #1. Frontier Centre for Public Policy Series No. 20 www.aims.ca/library/coxfinal.pdf

12. **"SMART GROWTH": Threatening the Quality of Life ,** Wendell Cox, AIMS Urban Futures Series, Paper #1. Frontier Centre for Public Policy Series No. 20 www.aims.ca/library/coxfinal.pdf

Methodology

The data

The key to this study was the ready availability of comparable data for these two cities under study. The data required for this study was:-

- "e00." Vector maps for CMA areas of Montreal and Toronto.
  From Census 2001'96,'91,'81,'71 Geographic Files
- Census Tract Data about New constructions for the years. :- 1946-1960 ; 1961-1970 ; 1971-1980 ; 1981-1990; 1990-1995 ; 1996-2001
- Census Tract Data about Population (100% sample) for the years. :- 1971-1980 ; 1981-1990; 1990-1995 ; 1996-2001
  From CHASS website: - http://www.chass.utoronto.ca

The software environment used to analyze this data was Microsoft excel and ArcMap.

Methodology

Two distinct approaches were used to examine these data: Comparative analysis of the "new housing construction" and "population density" of these two cities and a vector analysis based on concentric rings in Arc Map. Neither approach, on its own, provides a complete picture, but the combination of both approaches, although does not necessarily capture the full complexity of spatial patterns, provides a certain depth of vision.

The population density for each census tract was calculated in each census period as :-
(Population of census tract / Area of Census tract).

These excel tables containing data gathered for each census period from the CHASS website for both for Montréal and Toronto were then combined with the respective shape files, in ArcMap to do a vector based analysis of the problem.

1. Actual Number of New Housing Constructions and Population Densities were projected for each census period were projected on the shape files of respective cities.

2. Concentric rings with the CBD's as the center and each expanding with a 5 kms interval were drawn on the GIS map for the census periods.

3. Census tracts lying within these concentric rings namely, 0 to 5 kms from the CBD, 5 – 10 kms , 10 – 15 kms and so on up to 35 kms, were selected using the selection tools in ArcMap and exported in dbf format in excel to calculate the average number of new housings and population density.

These steps were performed for both cities to obtain the data in the following simple format:-

MONTREAL - NUMBER OF NEW HOUSING CONSTRUCTIONS						
	1946-1960	**1961-1970**	**1971-1980**	**1981-1990**	**1991-1995**	**1996-2001**
0-5 KMS	51340	35830	20515	17945	4315	4590
5 -10 KMS	129130	96560	57390	38200	9550	7905
10-15 KMS	57330	88950	72550	44105	12300	11285
15-20 KMS	21035	29785	33355	30795	8600	9445
20-25 KMS	27630	39800	49780	39400	15760	9795
25-30 KMS	16370	20720	30400	24085	12280	6875
30-35 KMS	8930	10255	19215	18285	10780	7490
35 +	12375	12900	18860	22895	15070	8760

TORONTO - NUMBER OF NEW HOUSING CONSTRUCTIONS						
	1946-1960	1961-1970	1971-1980	1981-1990	1991-1995	1996-2001
0-5 KMS	38580	39305	27245	23275	6630	8945
5 -10 KMS	64810	44035	34880	18605	6960	8565
10-15 KMS	92115	98650	66545	34295	10115	13275
15-20 KMS	25230	47210	62870	34490	7390	11040
20-25 KMS	19230	28970	50890	58480	17360	36865
25-30 KMS	9430	22380	42225	48190	12670	19220
30-35 KMS	10540	11580	23545	37705	5510	20965
35 +	21015	22725	33950	37840	13070	25005

For better understanding and analysis tables showing new housing construction for a particular buffer as a % of the total No of New housing for the city was drawn up for each city and for each Census period. Eg.

% of New Housing Construction within 10-15 kms (Toronto) for 1981-1990 = (Average No of New housings 1981-1990 within 10-15 kms/ total no of New housing in Toronto 1981-1990) x 100

TORONTO - % OF NEW HOUSING CONSTRUCTIONS						
	1946-1960	1961-1970	1971-1980	1981-1990	1991-1995	1996-2001
0-5 KMS	14.59	13.70	8.98	7.45	6.25	6.15
5 -10 KMS	24.51	15.34	11.49	5.96	6.56	5.89
10-15 KMS	34.84	34.37	21.92	10.98	9.53	9.13
15-20 KMS	9.54	16.45	20.71	11.04	6.96	7.60
20-25 KMS	7.27	10.09	16.77	18.72	16.35	25.36
25-30 KMS	3.57	7.80	13.91	15.43	11.93	13.22
30-35 KMS	3.99	4.04	7.76	12.07	5.19	14.42
35 +	7.95	7.92	11.18	12.11	12.31	17.20

MONTREAL - % OF NEW HOUSING CONSTRUCTIONS						
	1946-1960	1961-1970	1971-1980	1981-1990	1991-1995	1996-2001
0-5 KMS	17.68	12.52	8.03	7.36	5.03	7.50
5 -10 KMS	44.47	33.75	22.48	15.68	11.13	12.91
10-15 KMS	19.74	31.09	28.41	18.10	14.34	18.44
15-20 KMS	7.24	10.41	13.06	12.64	10.02	15.43
20-25 KMS	9.52	13.91	19.50	16.17	18.37	16.00
25-30 KMS	5.64	7.24	11.91	9.88	14.31	11.23
30-35 KMS	3.08	3.58	7.53	7.50	12.56	12.24
35 +	4.26	4.51	7.39	9.40	17.57	14.31

Similarly Average population densities were tabulated for both these cities. Due to the unavailability of shape files before 1971 population densities could not be calculated.

TORONTO – AVERAGE POPULATION DENSITY						
	1971	1981	1991	1996	2001	
0-5 KMS	11678	8521	10630	10907	11221	
5 -10 KMS	10765	5448	6850	6234	6583	
10-15 KMS	9419	4664	4612	5398	5663	
15-20 KMS	5975	3831	2982	4163	4261	
20-25 KMS	3207	2860	2109	3036	3276	
25-30 KMS	2882	1802	2118	2387	2523	
30-35 KMS	1693	1075	1701	2131	2229	
35 +	937	944	1715	1381	1448	

MONTREAL – AVERAGE POPULATION DENSITY						
	1971	1981	1991	1996	2001	
0-5 KMS	19644	12533	11536	10865	11097	
5 -10 KMS	12780	9148	7428	7575	7708	
10-15 KMS	5314	4423	3977	4025	4015	
15-20 KMS	2868	1954	1948	2437	2436	
20-25 KMS	1536	1570	2241	1942	1933	
25-30 KMS	1112	1305	1611	1472	1484	
30-35 KMS	889	627	1186	882	921	
35 +	56	384	944	682	709	

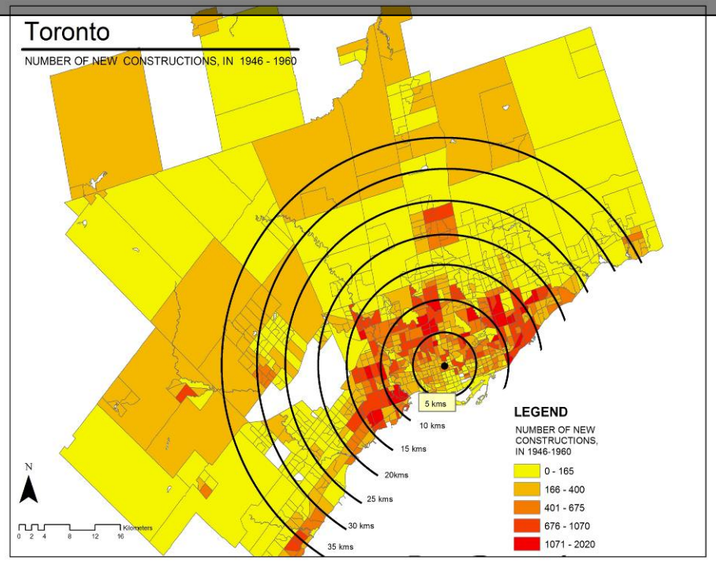
A comparative study and a cursory analysis of these data for Toronto and Montreal by line graphs along with the GIS maps brings out interesting differences between the two cities findings and results in the following pages. The analysis which follows is descriptive and comparative. No systematic attempt has been made to explain the patterns. It is obvious that the patterns which emerge have been influenced by local physical geography, policies, provincial borders, highway development, regional planning, infrastructure, history, early or late industrialization, metropolitan industrial structure, and probably to some extent cultural predispositions and preferences. The exploration of these factors opens up rich possibilities for further studies.

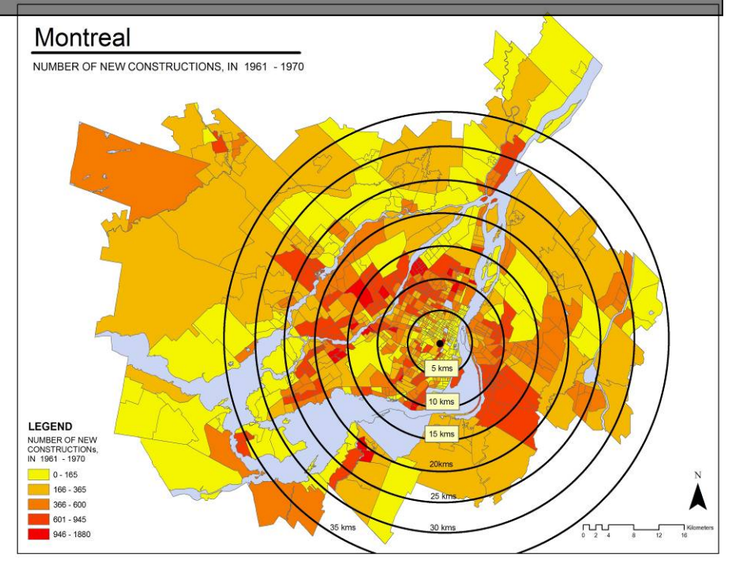
Observations and Findings

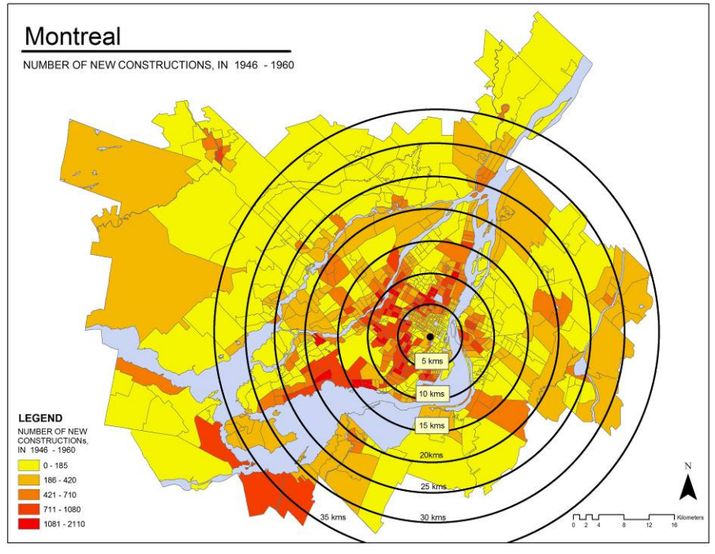
Comparing the maps and graphs of Montréal and Toronto's New Construction in the **period of 1946-1960**, reveals that maximum growth for both these cities took place within 0 – 15 kms from the CBD.

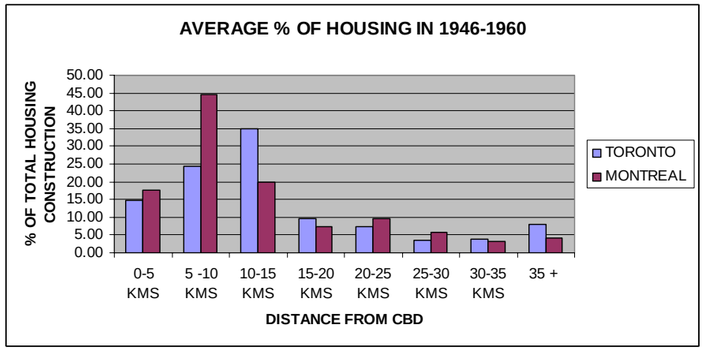
Montreal's 45 % of the new housing in this period lies between the distance of 5-10 kms from the CBD, while 35 % of Toronto's new housing lies in the distance of 10-15 kms. Both these figures show that most new housing developments were concentrated within the distance of 15 kms from the CBD for both these cities.

It is question at this point if the growth beyond 25 kms from the CBD can be called suburban growth or rural growth for these cities.

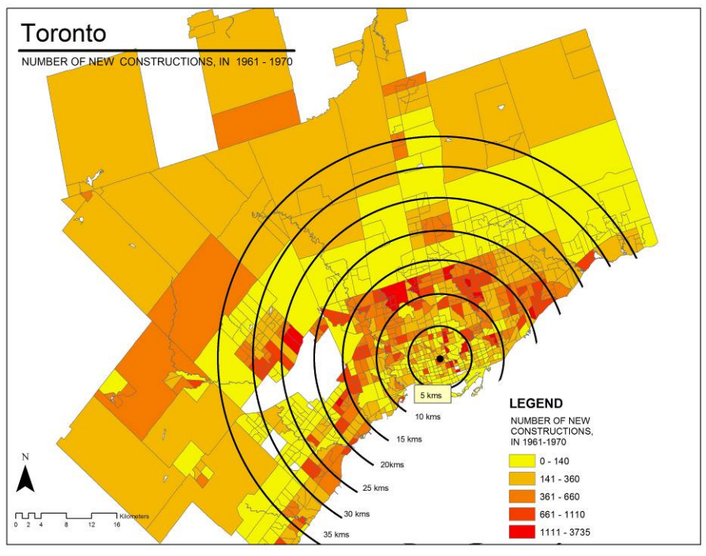




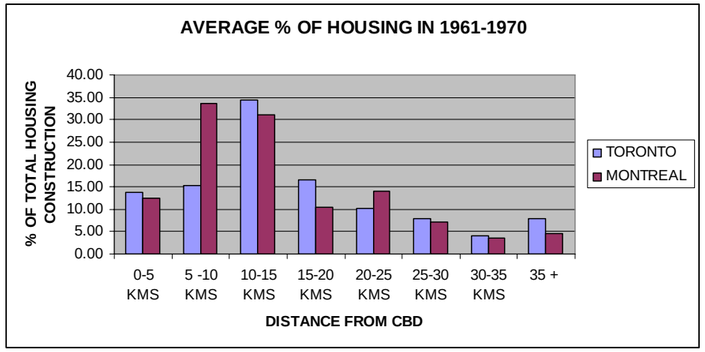




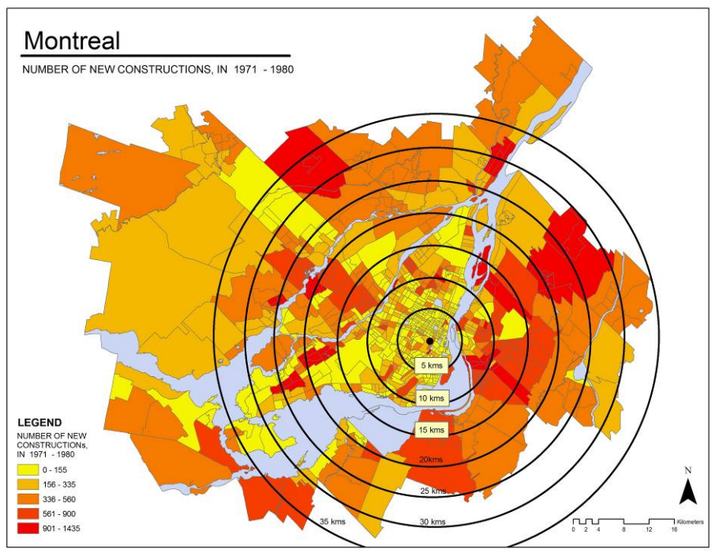
During the **period of 1961-1970,** Montréal had very high % of new housing constructions in the distance of 5 – 15 kms from the CBD. It is also of interest to note that Toronto on the other hand had a very high % (up to 35 %) within 10-15 kms from the CBD.

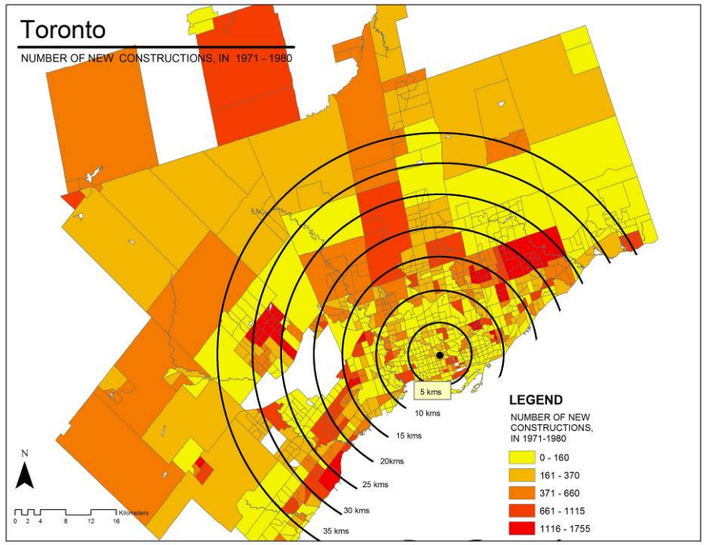


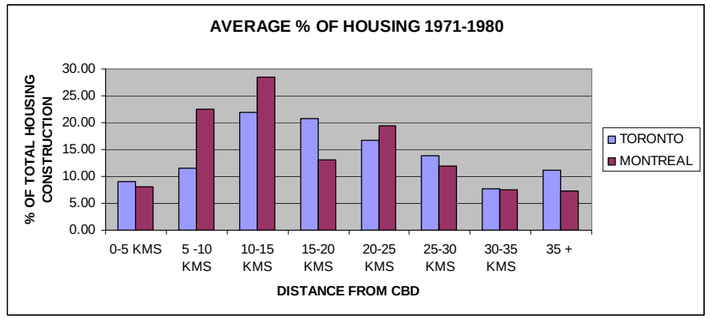
On the whole one can say that the regions from 0-25 kms are undergoing a construction boom for New Housing for both these cities.



The **period of 1971-1980** clearly marks the beginning of what we call sprawl for both these cities. We can see the rise in new housing beyond the distance of 20 kms from the CBD.



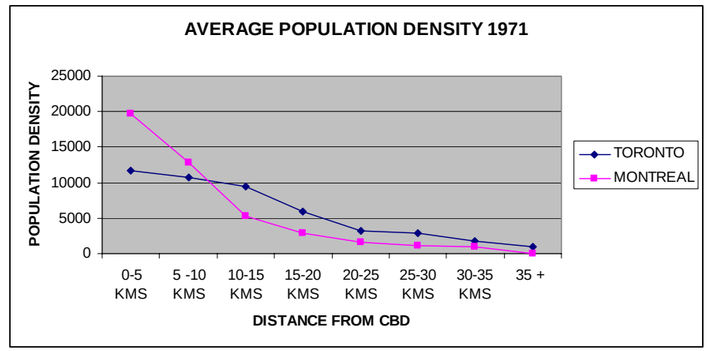




Montreal still in this decade has a very high share of new housing within 5 -15 kms while Toronto has seen a more even growth in the distance of 10-25 kms from CBD.

The population density comparative graph plotted for these two cities complements the above observation. Population density drops sharply for Montréal till a distance of 15 kms from the CBD. It is still higher than Toronto till a distance of 10 Kms from the CBD after which it slops gradually. Toronto on the other hand has a higher population density that Montreal beyond the first 10 kms from the CBD.

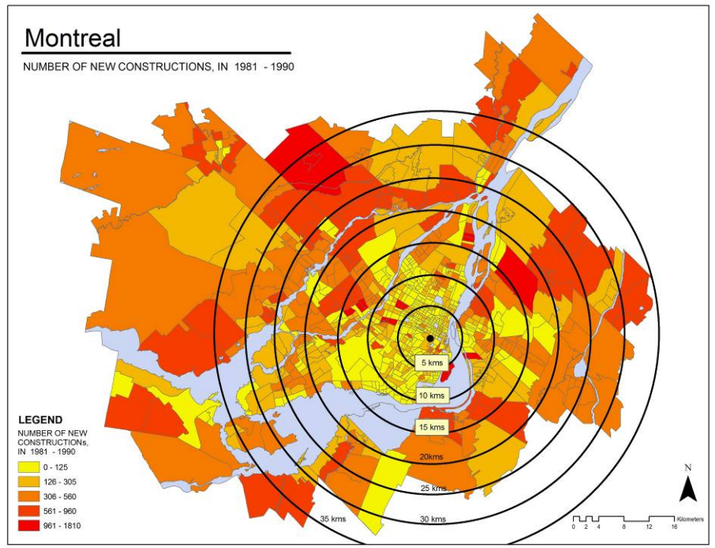
This graph clearly brings out the fact that Toronto is a relatively more sprawling city than Montreal where the maximum population is concentrated within the first 15 kms from the CBD.

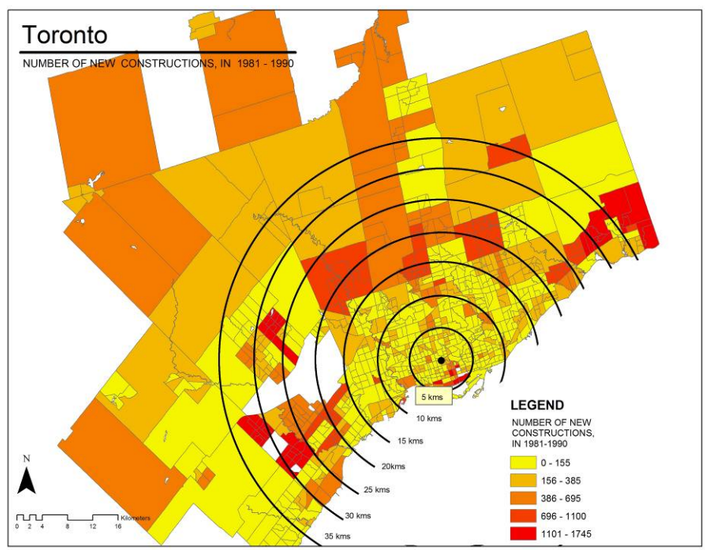


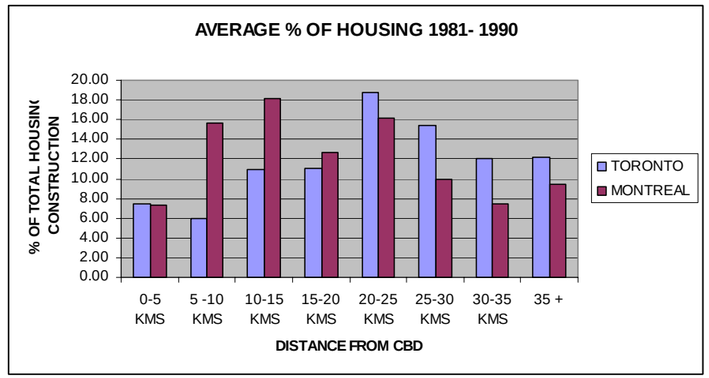
The **period of 1981-1990** brings out a trend which we can see being followed in the later decades.

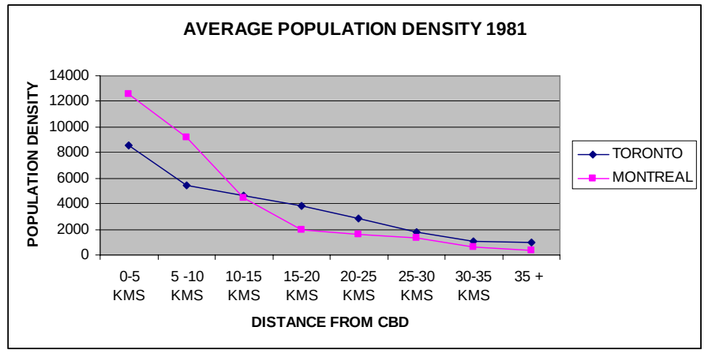
A very high share of Toronto's new housing construction lies beyond a distance of 20 kms from the CBD while Montreal growth in terms of new housing is still concentrated predominantly within the first 25 kms. This affirms that Toronto grew as a more important city over Montréal in this decade, a

trend which is still prevalent as we will see in the next few pages.



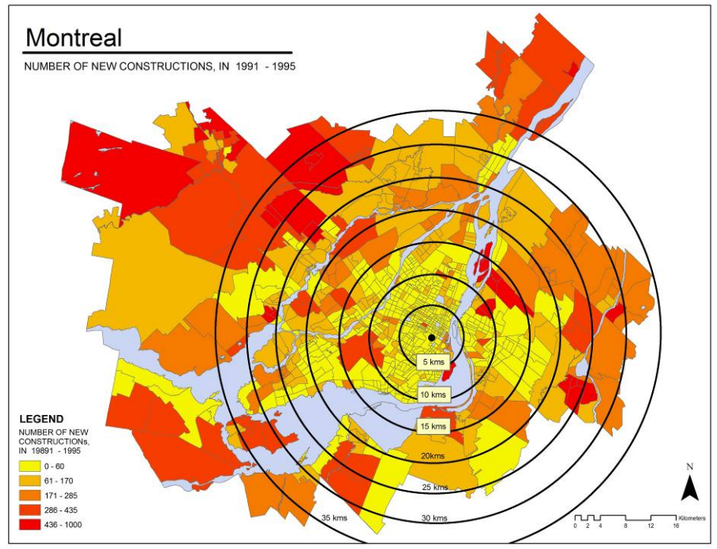




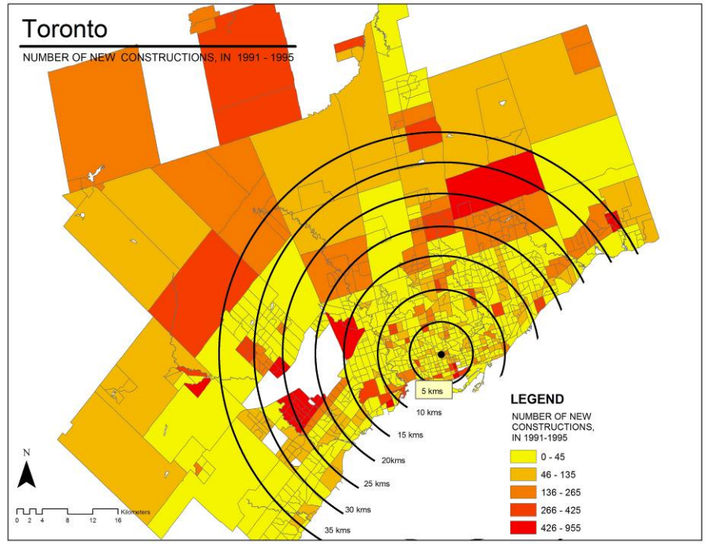


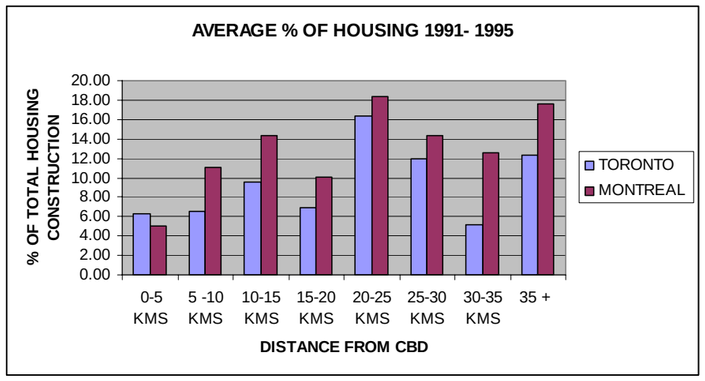
The two graphs above still show that Montreal had a higher population density than Toronto within a distance of 15 kms from the CBD. However there is a relative increase in the population densities of both these cities with increasing distance from the CBD as compared with the population densities of both these cities in 1971. This along with the new housing Construction graphs and maps is a clear indication of the choice which people made or had to make while locating themselves in these two cities in this decade.

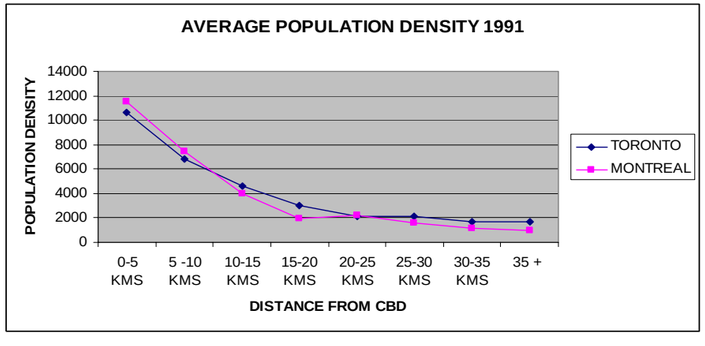
The period **of 1991-1995** shows that Montreal has picked up the existing trend of Suburban Growth. Also Montreal in these 5 years has more new housing beyond the first 25 kms from the CBD. Even though while 10-15 % of new housing Constructions lie within 5-15 kms is obvious that development is taking place in the surrounding regions or Laval and Longueuil.



It is of interest to note that both Montreal and Toronto have more or less similar Population density curves in 1991. Even though the Population density in Toronto is slightly higher than Montreal at a distance of 35 kms, the population densities are higher for both these cities as compared to 1981.



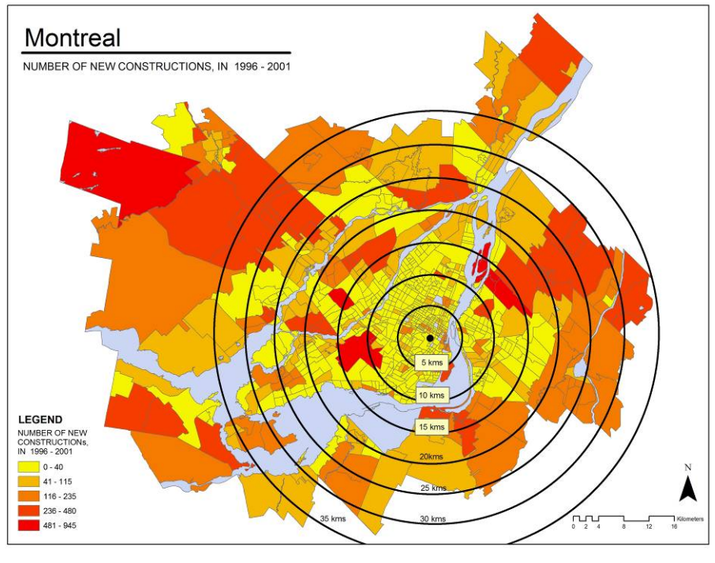


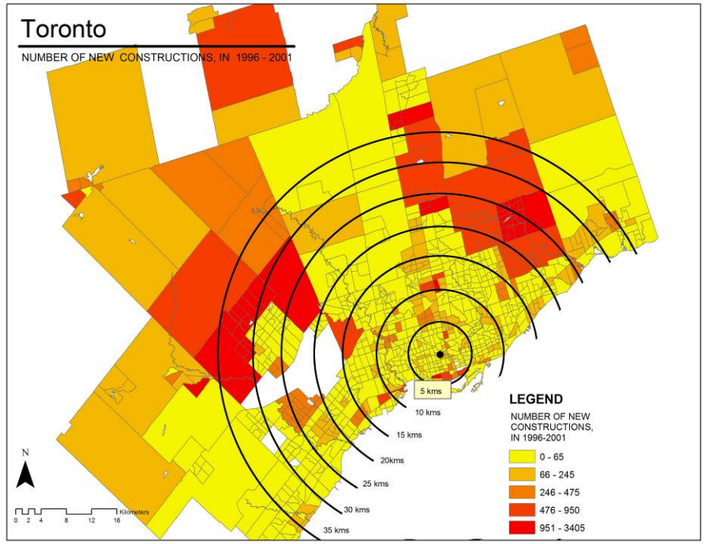


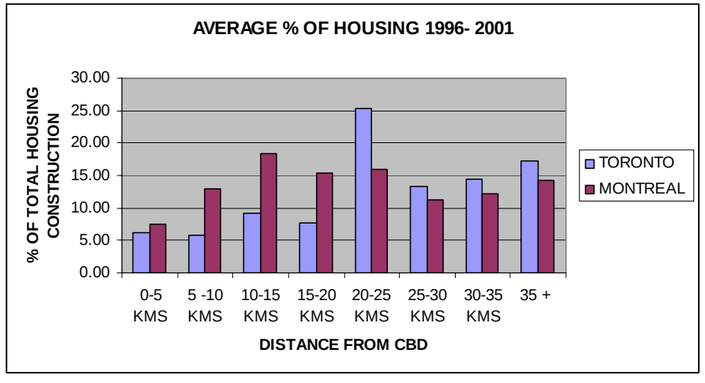
The period **of 1996-2001** we see that the population density in Toronto (2001) has increased beyond a distance of 20 kms from the CBD as compared to the one in 1991. This is also complemented by the housing graph where we see that there is definitely more new housing beyond 20 kms from CBD.

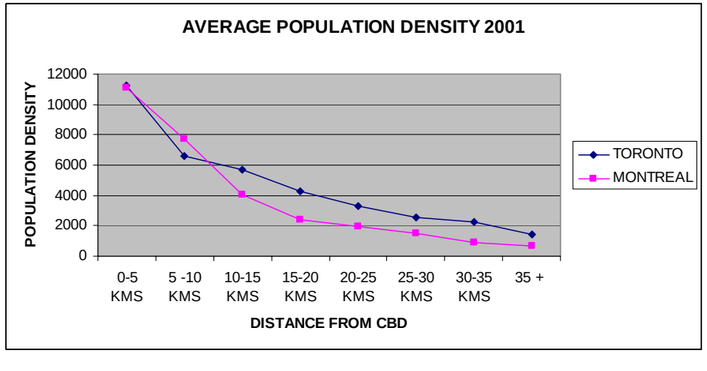
Montréal on the other hand has a more even distribution of new housing within a distance of 5 -35 kms. Also the population density curve of Montreal has also not shown any drastic change from 1981.

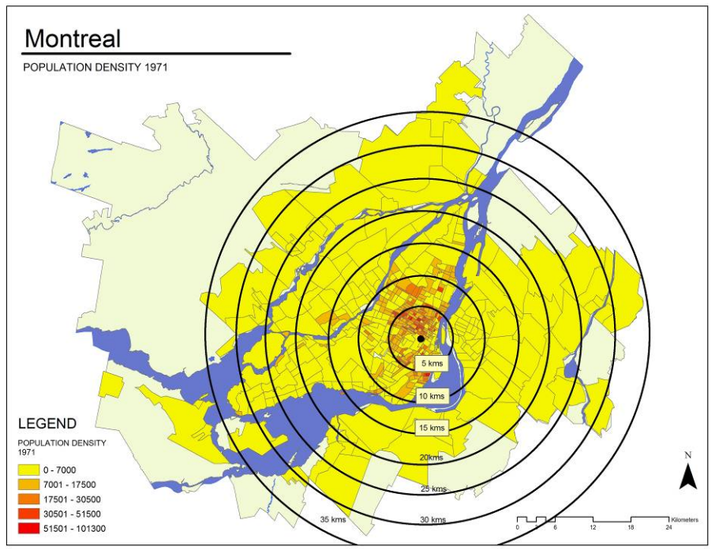
The difference between the population density curves of Montreal and Toronto are significant. On the whole Toronto has a higher population density than Montreal except within 5-10 kms from the CBD, where Montreal has a higher population density.



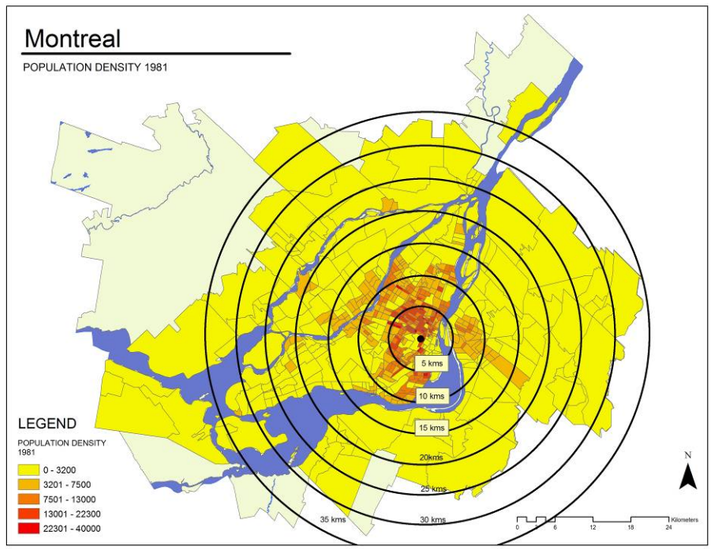








MONTREAL POPULATION DENSITY 1971



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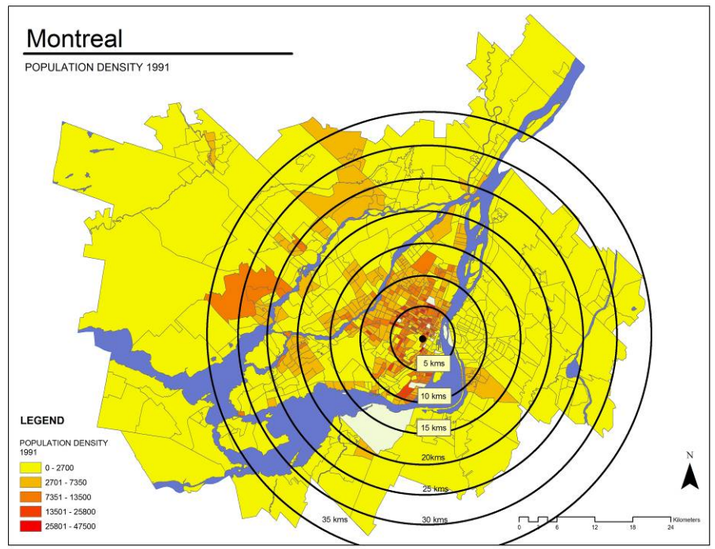

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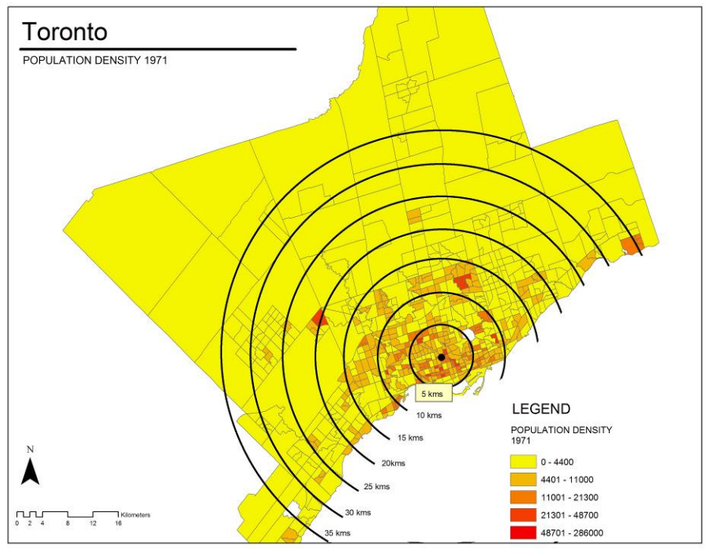
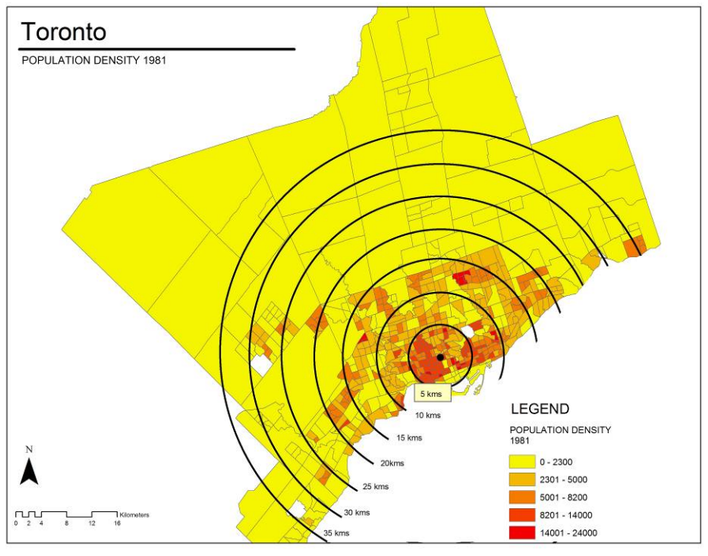


TORONTO POPULATION DENSITY 1971



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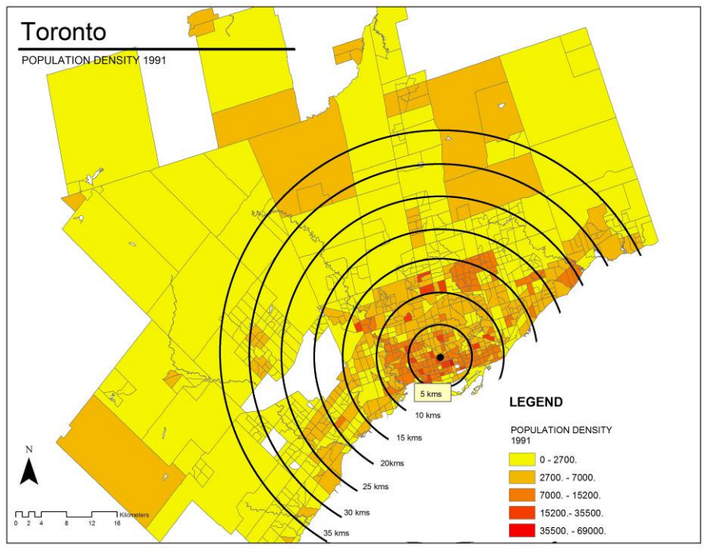

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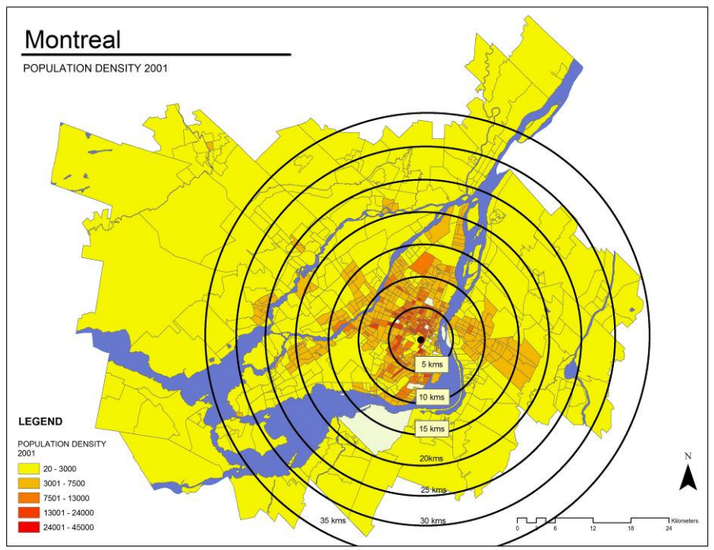
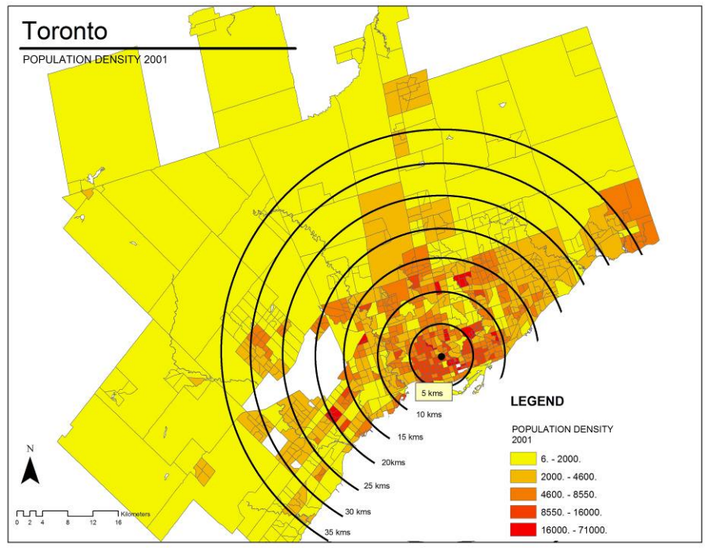


MONTREAL POPULATION DENSITY 2001



TORONTO POPULATION DENSITY 2001

Conclusions

Looking at the tables, graphs and maps above there are definitely some clear trends and patterns which have emerged. On one hand there is evidence to suggest that similar forces are at work in terms of growth in both the cities. But beyond the straightforward observation that these cities are growing and growth is concentrated in the suburbs it is clear that the suburbs of Toronto better known as the *Greater Toronto Area* has received perhaps the most attention with respect to the issue of urban sprawl in the last 3 decades.

In particular, growth in Montreal is limited to a small number of centers and to areas relatively close to the city centre, whereas in Toronto it is spread over a large number of more distant centers.

On the whole we can safely say that Clark's density model is still valid for these two Canadian Cities. However we must also note that dense living is not on the rebound. Population densities of both these cities with the first 10 kms from the CBD's have more or less remained the same throughout the study period. As a matter of fact they have gone up In Toronto since 1971.

The complex nature of urban sprawl requires multiple sprawl indicators. This paper is merely a scratch on the surface and does not explore this phenomenon in depth. The different forces responsible for shaping these cities should be analyzed and we will see that only that it is the cities unique geography; institutional framework, culture, and history which interact to produce unique spatial outcomes. Sprawl indicator measures calculated at housing-unit- Census Tract level provide an advantageous set of tools for evaluating and informing the development process. Sprawl is inherently a dynamic phenomenon, and this paper is an approach to capture this dynamism by incorporating the population density over distance and time.

{The Toronto urban area is the largest in Canada, and constitutes approximately one-fifth of the country's total urban population. The Toronto area has grown very rapidly, with a 262 percent increase from 1951 to 2001. Toronto's growth has been comparatively dense. According to the 2001 census, the Toronto urban area has 2639 persons per square kilometer, 42 percent more than the second-most dense major urban area, Montreal, and approximately three times the average national urban density. Toronto's suburbs alone

are more densely populated than the entire Montreal urban area (core city and suburbs) and more dense than any other major urban area in Canada.} *

* **A tale of four cities: intra-metropolitan employment, distribution in Toronto, Montréal, Vancouver,and Ottawa hull, 1981 - 1996.**
Richard Shearmur and William J Coffey.

Limitations of Study

1. Census Tract Data from Statistics Canada about "New constructions" does not clearly define what the units of analysis are. Also the units of analysis may not be necessarily be of the same area. A more systematic and in depth analysis by including variables like **"household sizes"; "housing Typology"** should also be incorporated in this study.

2. There could be more that one sub units in one big building.
   For example: - A condominium building in spite of containing 50 dwellings might still be counted as one unit, similar to a single detached row house.
   This might warp the real picture while looking at the densities of new constructions.

3. In some cases Census Tract Data was not available for certain Census tracts and this reflects in the GIS maps as blank white spaces.

4. {**"Polycentricity" or "Multinucleation", "Edge-city forms"** are not taken into account in this study. Unfortunately due to lank of data few studies have explored this phenomenon and its impact on Housing and Population Density in the North American Cities. } *

5. "Average Population densities "and "Average No. of new Housing Construction" in a buffer differs/may differ substantially from the actual values. Also using the average might be a reductionist approach to the whole problem. Also the problem with these gross density measures is that it includes all land within a given Census Tract even though much of that land might well be unoccupied or unoccupiable. Such land deflates the average population density. Further, such measures provide no information about the variability of density across an urban region

6. On numerous occasions certain Census Tracts which are polygons on the map spanned across many buffers. This did add to a certain level of inaccuracy in this analysis.

7. { In the empirical literature on sprawl, there is a debate about whether to measure sprawl using the density of population or the density of dwellings. Advocates of the dwellings approach argue that, with the decline in average household size in the last century, the same stock of dwellings contains fewer people with the passing of time. Thus, built form of the city may remain unchanged, yet population density declines. While this is undoubtedly true, this paper has used population density measures throughout in keeping with the majority of the literature. However, the reader should be mindful of the "drift" in average population density that is possible over time because of a shrinking household size. } **

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* "**Polycenricity' or "Multinucleation"** :- A spatial structure that includes one or more specialized economic nodes other than the CBD.
"Edge-city forms" :- Decentralization of firms to increase their access to labor pools"

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** **Urban sprawl in Canada and America: just how dissimilar?**
John R. Miron (Professor of Geography and Planning. University of Toronto at Scarborough)
http://www.citieslab.utsc.utoronto.ca/Papers/UrbanSprawl.pdf

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