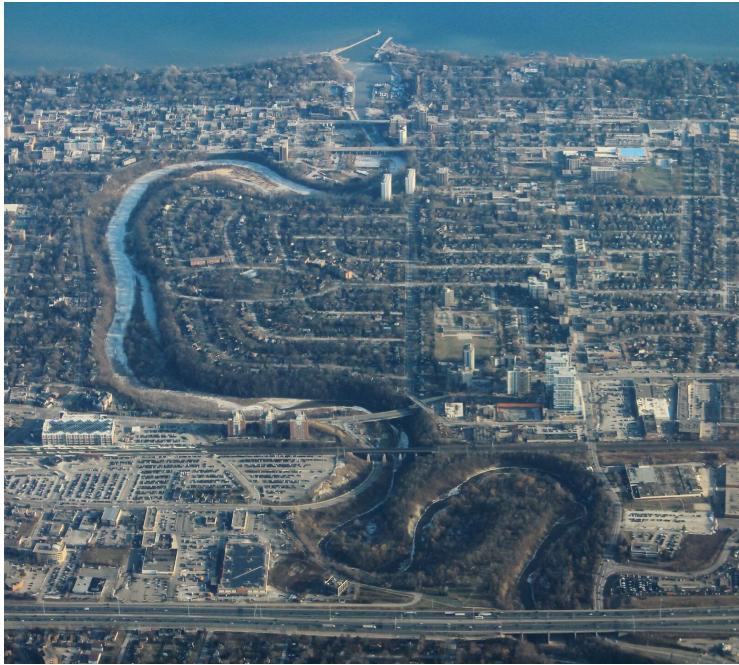


# Urban Sprawl impacts on Halton Region's Population and Landscape



# Introduction

- Halton Region demonstrating significant population growth - anticipated to have major effects on extent built environment
- Rise in population resulting in farmland (5,200 acres) proposed for development (McIntosh, 2022)
- Goal of our analysis is to process main land-cover types, allowing cross-examination of changes with encroachment on key areas
- Processing of land-cover types and specific areas involved in study will be elaborated on - methodology &



Downtown Oakville Area

Photo credit:  
formulanone / Flickr

# Introduction (Remarks on Terminology)

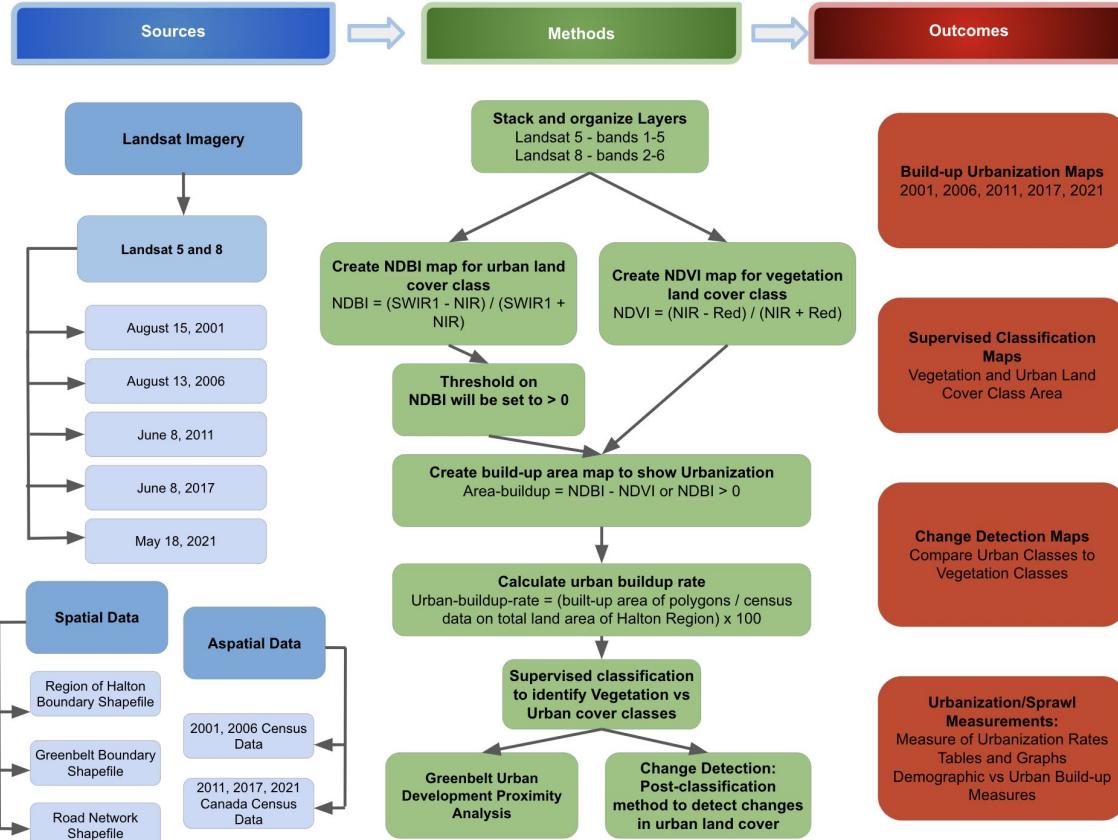
- In our research, urban areas and urbanization are used to refer to land which is developed from agricultural to residential/industrial
- From examination of landsat images, clear trend that Halton region is (spatially) mostly residential with industrial zones
- Thus, usage of term “urban” is different (i.e. compared to urban areas in Toronto)

# Research Objective

- Research focuses on how the amount of urbanization has compared with the increase in population and affected its landscape within recent years
- Our objective with our research is to use Landsat 5 and 8 images from 2001 to 2021 to analyze the rates of urban sprawl growth by measuring built-up urban areas
- Advocate urban Sprawl awareness and promote sprawl mitigation strategies in Halton Region
- Key component of advocacy is rooted in environmental concerns connected to Greenbelt



# Research Methodology



- Census data for each Landsat Image year was used in comparison the urban sprawl rate in the Halton Region

# Methodology (Continued)

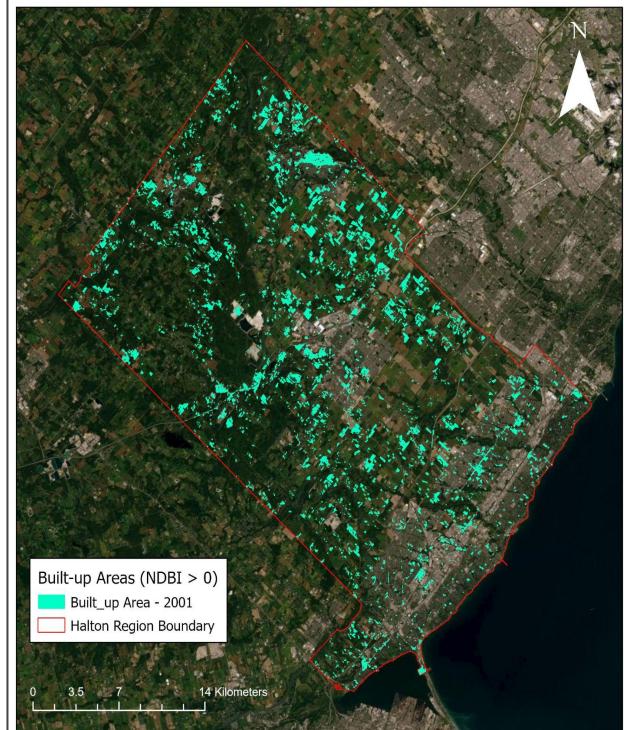
- Supervised classification was used on each of the 5 landsat stacked images
- Change detection using Matrix Union tool was used on each **pair** of consecutive census years
- NDBI was calculated and used to create maps of build-up areas
- With

Row	Histogram	Class_Names	Color	Opacity	area_change_(sqmiles)
0	1395474	Unclassified / no change		0	484.916
1	9796	Urban / no change		1	3.40403
2	10354	Urban to Res / changed!		1	3.59793
3	2193	Urban to Veg / changed!		1	0.76205
4	46976	Res to Urban / changed!		1	16.3238
5	285296	Residential / no change		1	99.1381
6	87693	Res to Veg / changed!		1	30.4726
7	83846	Veg to Urban / changed!		1	29.1358
8	201440	Veg to Res / changed!		1	69.9988
9	346532	Vegetation / no change		1	120.417

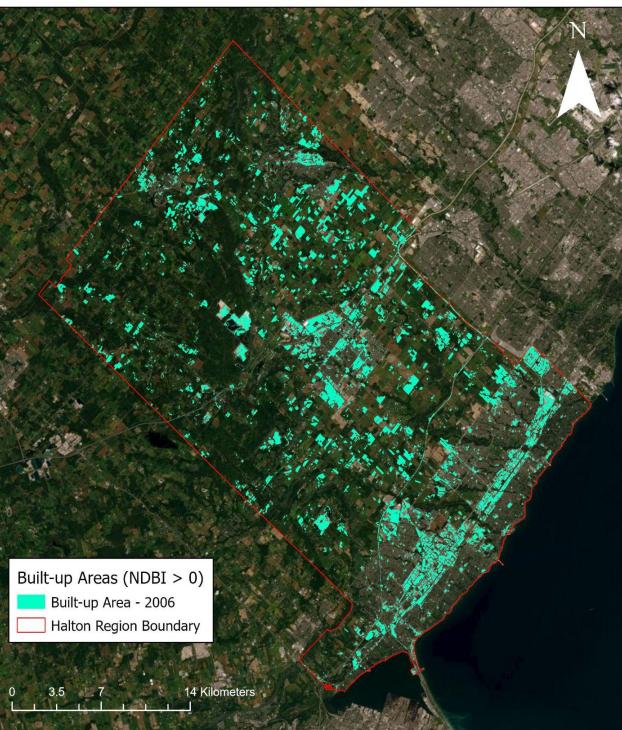
- ◀ Example table of change detection layer to which class names were added
- ◀ (same color scheme applied to all 5 change detection images)

# Build-up Areas

Build-up Areas in Region of Halton - 2001



Build-up Areas in Region of Halton - 2006



Build-up Areas in Region of Halton - 2011

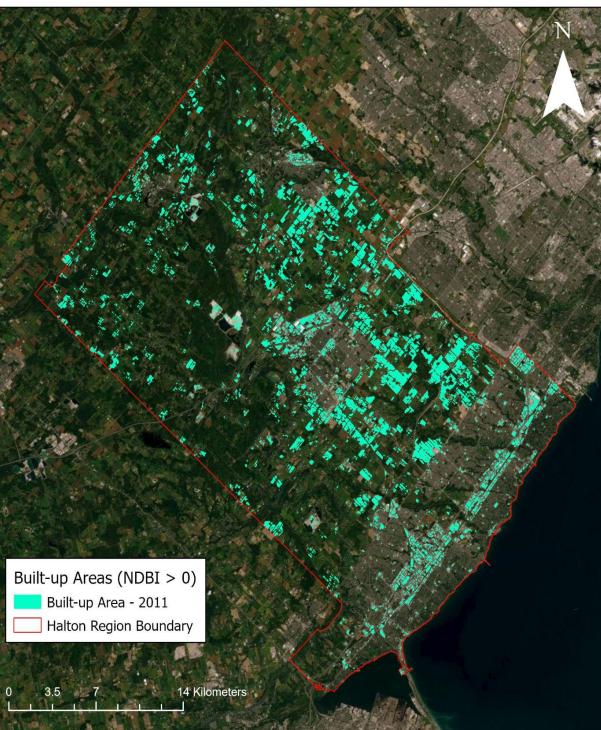


Image Details:  
LT05\_12SP\_018030\_20010815\_20200906\_02\_T1  
Landsat 5, MSS/TM sensors  
Bands 1-5  
Acquisition date: August 15, 2001

Map created by: GGR335 Group #10  
March 20, 2022

Data Sources: USGS, Ontario Ministry of Municipal Affairs and Housing  
Map Projection: WGS\_1984\_UTM\_Zone\_17N  
Municipality of Halton Region, ON

Image Details:  
LT05\_12SP\_018030\_20060813\_20200831\_02\_T1  
Landsat 5, MSS/TM sensors  
Bands 1-5  
Acquisition date: August 13, 2006

Map created by: GGR335 Group #10  
March 20, 2022

Data Sources: USGS, Ontario Ministry of Municipal Affairs and Housing  
Map Projection: WGS\_1984\_UTM\_Zone\_17N  
Municipality of Halton Region, ON

Image Details:  
LT05\_12SP\_018030\_20110608\_20200822\_02\_T1  
Landsat 5, MSS/TM sensors  
Bands 1-5  
Acquisition date: June 8, 2011

Map created by: GGR335 Group #10  
March 20, 2022

Data Sources: USGS, Ontario Ministry of Municipal Affairs and Housing  
Map Projection: WGS\_1984\_UTM\_Zone\_17N  
Municipality of Halton Region, ON

# Build-up Areas

Build-up Areas in Region of Halton - 2017

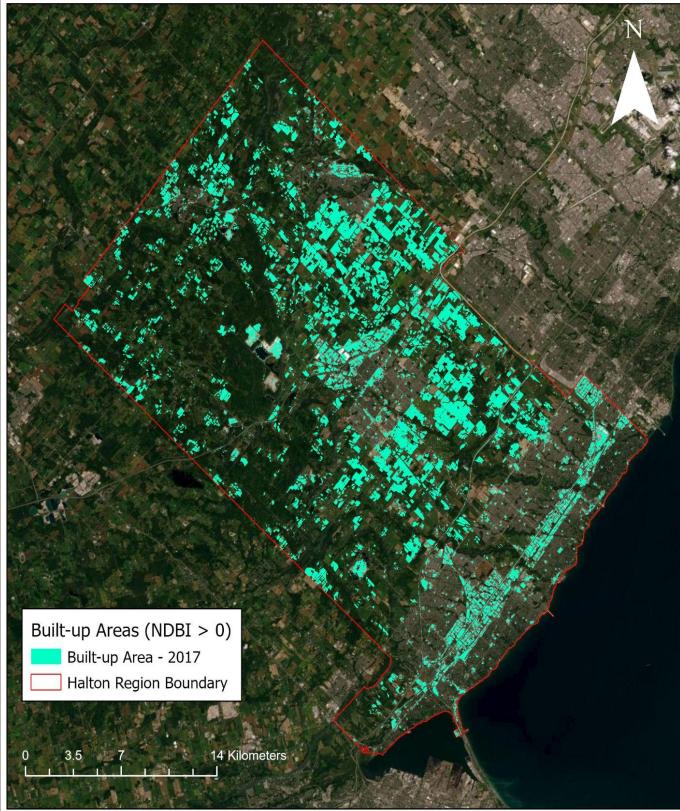


Image Details:  
LC08\_L2SP\_018030\_20170608\_20200903\_02\_T1  
Landsat 8, OLI/TIRS combined sensor  
Bands 2-6  
Acquisition date: June 8, 2017

Map created by: GGR235 Group #10  
March 20, 2022  
Data Sources: USGS, Ontario Ministry of Municipal Affairs and Housing  
Map Projection: WGS\_1984\_UTM\_Zone\_17N  
Municipality of Halton Region, ON

Build-up Areas in Region of Halton - 2021

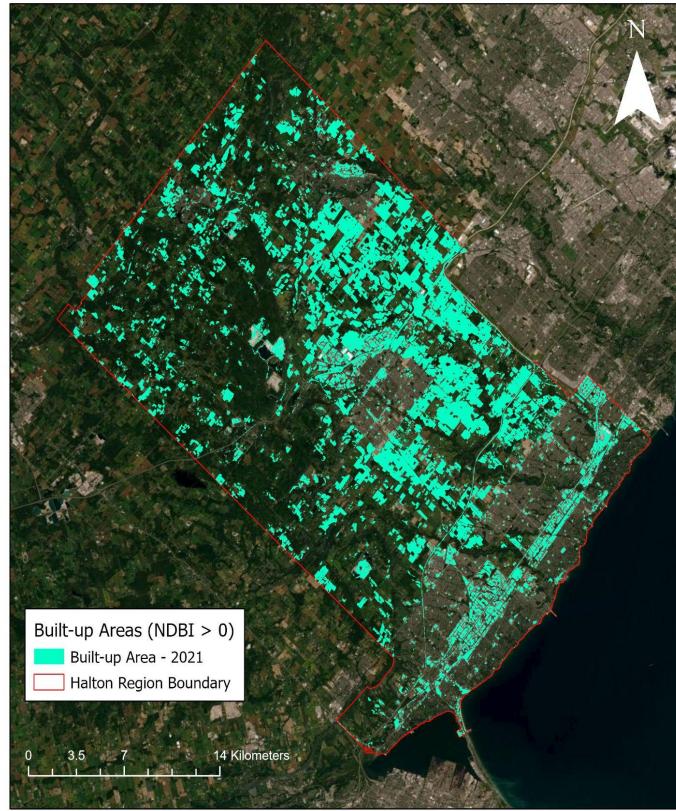


Image Details:  
LC08\_L2SP\_018030\_20210518\_20210528\_02\_T1  
Landsat 8, OLI/TIRS combined sensor  
Bands 2-6  
Acquisition date: May 18, 2021

Map created by: GGR235 Group #10  
March 20, 2022  
Data Sources: USGS, Ontario Ministry of Municipal Affairs and Housing  
Map Projection: WGS\_1984\_UTM\_Zone\_17N  
Municipality of Halton Region, ON

# Urbanization/Sprawl Measurement Results

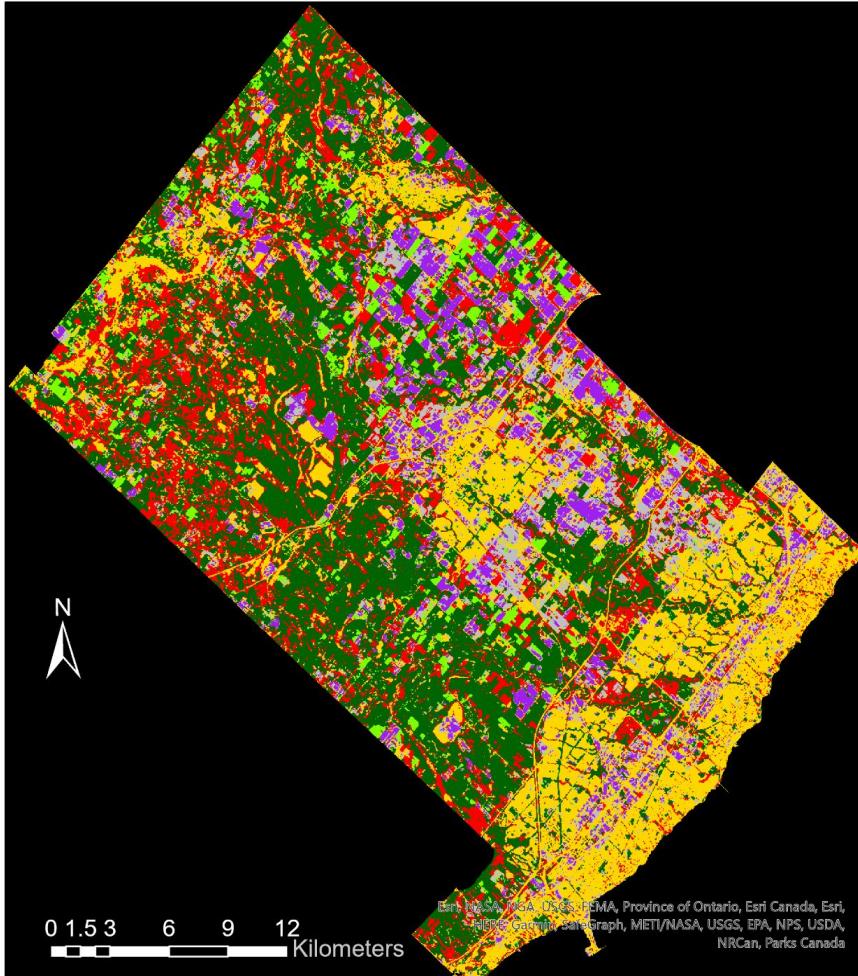
Table 1: Demographic vs. Urban Built-up Rate of Halton region

Year	Population	Population Density (per sqkm)	Total Land Area (sqkm)	Total Built Area (sqkm)	Urban Build-up Rate(%)
2001	375,229	388.0	967.04	75.9742	7.86%
2006	439,256	454.2	967.17	91.3231	9.44%
2011	501,669	520.4	964.01	93.202	9.67%
2017	548,435	568.9	964.05	142.157	14.75%
2021	596,637	617.8	965.71	202.239	20.94%

- Population growth is a leading factor for urban sprawl
- Rapid expansion of Built-areas that encompass of low-density residential housing, single-use zoning, and expansion of road networks to accommodate the rapid growing population
  - Much of this expansion has likely taken place even prior to 2001

# Change Detection Results

- Errors in urban and Vegetation-to-urban (purple & red)
- Areas of interest are in clusters where residential areas are developed
- Small degree of urbanization overall Between 2001-2021, Example given in 2017-2021:



Change Detection of Halton Region  
(2017 to 2021)

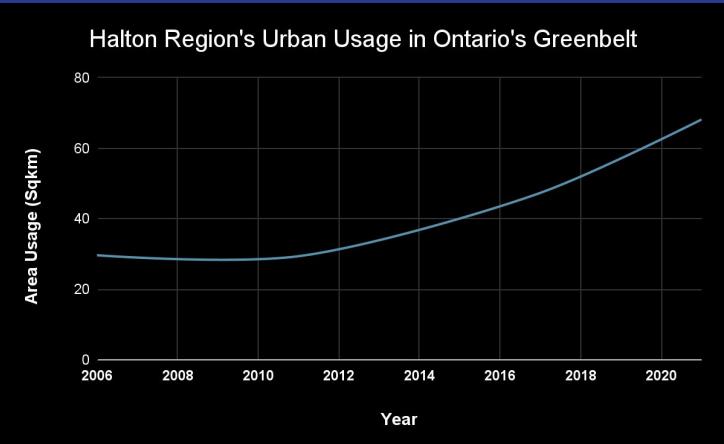
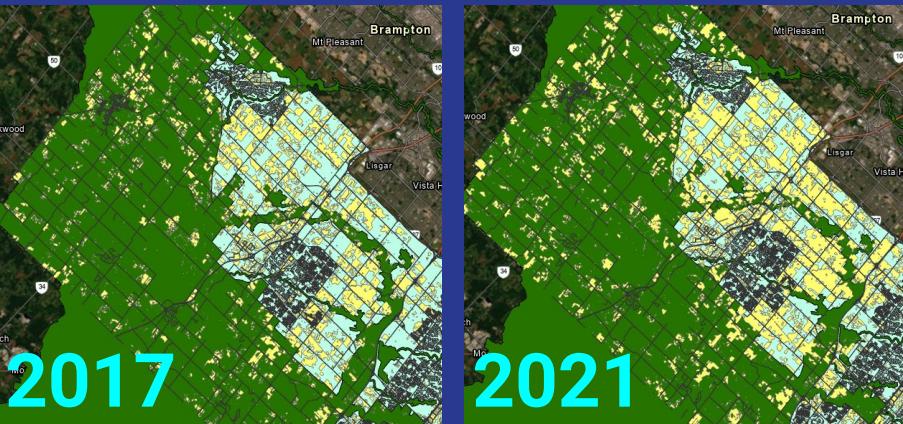
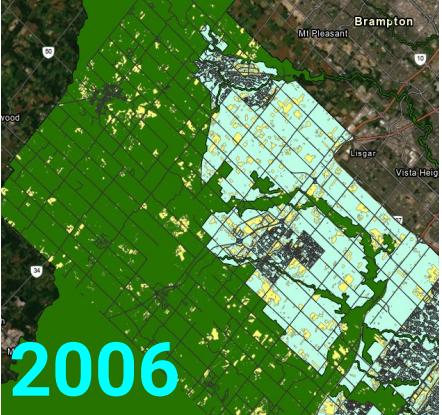
## Legend

Unclassified (no change)	Residential (no change)
Urban (no change)	Residential to Vegetation
Urban to Residential	Vegetation to Urban
Urban to Vegetation	Vegetation to Residential
Residential to Urban	Vegetation (no change)

Authors: Group 10 (GGR335)  
Date Created: March 21 2022  
Data Sources: USGS, Ontario Ministry of Municipal Affairs and Housing  
Map Projection: WGS 1984 UTM Zone 17N  
Location: Halton Region, ON Canada

# Greenbelt Analysis Results

- Ontario's Greenbelt boundary is 2 million acres of protected land which:
  - Provides water, food and air
  - Protects farms
  - Offsets carbon ("Greenbelt Plan (2017)")
- Gradual development in Halton is approaching inside the Greenbelt
- This can compromise its control with urban sprawl and its environmental sustainability



# Discussions and Conclusion

- Developed areas in Halton region appear in change detection results to be increasing (more than they actually are)
  - Errors caused by classification misinterpreting rural land operations as “urban” land-cover
    - Results are skewed (exaggerated) relative to reality
  - NDBI concluded to be more accurate to represent small-scale/sporadic development (in predominantly agricultural lands)
- Most of population growth happening in already developed ('urbanized') areas
  - Visible (and proven) in the fact that population density has been increasing sharply)
- However, expansion of residential & industrial areas may increase if zoning changes are voted/passed this year (McIntosh, 2022)
  - Environmental consequence: lack of sustainability can lead to worse results (closer proximity to Ontario Greenbelt)

# References

Government of Canada, S. C. (2022, March 9). Road\_Network\_2006. Alternative format. Retrieved March 28, 2022, from

[https://www12-2021.statcan.gc.ca/census-recensement/alternative\\_alternatif.cfm?archived=1&lang=eng&dispxext=zip&teng=qrnf000r06a\\_e.zip&k=++214122&loc=http%3A%2F%2Fwww12.statcan.gc.ca%2Fcensus-recensement%2F2011%2Fgeo%2FRNF-FR%2Ffiles-fichiers%2Fqrnf000r06a\\_e.zip](https://www12-2021.statcan.gc.ca/census-recensement/alternative_alternatif.cfm?archived=1&lang=eng&dispxext=zip&teng=qrnf000r06a_e.zip&k=++214122&loc=http%3A%2F%2Fwww12.statcan.gc.ca%2Fcensus-recensement%2F2011%2Fgeo%2FRNF-FR%2Ffiles-fichiers%2Fqrnf000r06a_e.zip)

Government of Canada, S. C. (2022, March 9). Road\_Network\_2017. Alternative format. Retrieved March 28, 2022, from

[https://www12.statcan.gc.ca/census-recensement/alternative\\_alternatif.cfm?l=eng&dispxext=zip&teng=lrnf000r16a\\_e.zip&k=++319511&loc=http%3A%2F%2Fwww12.statcan.gc.ca%2Fcensus-recensement%2F2011%2Fgeo%2FRNF-FRR%2Ffiles-fichiers%2F016%2Flrnf000r16a\\_e.zip](https://www12.statcan.gc.ca/census-recensement/alternative_alternatif.cfm?l=eng&dispxext=zip&teng=lrnf000r16a_e.zip&k=++319511&loc=http%3A%2F%2Fwww12.statcan.gc.ca%2Fcensus-recensement%2F2011%2Fgeo%2FRNF-FRR%2Ffiles-fichiers%2F016%2Flrnf000r16a_e.zip)

Government of Canada, S. C. (2022, March 9). Road\_Network\_2021. Alternative format. Retrieved March 28, 2022, from

[https://www12.statcan.gc.ca/census-recensement/alternative\\_alternatif.cfm?l=eng&dispxext=zip&teng=lrnf000r21a\\_e.zip&k=++303076&loc=%2F%2Fwww12.statcan.gc.ca%2Fcensus-recensement%2F2021%2Fgeo%2Fsjp-pis%2FRNF-FRR%2Ffiles-fichiers%2Flrnf000r21a\\_e.zip](https://www12.statcan.gc.ca/census-recensement/alternative_alternatif.cfm?l=eng&dispxext=zip&teng=lrnf000r21a_e.zip&k=++303076&loc=%2F%2Fwww12.statcan.gc.ca%2Fcensus-recensement%2F2021%2Fgeo%2Fsjp-pis%2FRNF-FRR%2Ffiles-fichiers%2Flrnf000r21a_e.zip)

Greenbelt Plan mapping. Greenbelt Plan mapping - Datasets - Ontario Data Catalogue. (n.d.). Retrieved March 28, 2022, from  
<https://data.ontario.ca/dataset/greenbelt-plan-mapping>

"Greenbelt Plan (2017)." Ontario.ca, Queen's Printer for Ontario, 2012–22, 6 Aug. 2019,  
<https://www.ontario.ca/document/greenbelt-plan-2017>.

McIntosh, E. (2022, February 10). Will Ontario's Halton Region open 5,000 acres of farmland for development? The Narwhal.  
<https://thenarwhal.ca/halton-farmland-sprawl/>

Statistics Canada. (2002, March 12). 2001 community profiles. Statistics Canada: Canada's national statistical agency / Statistique Canada : Organisme statistique national du Canada. Retrieved March 20, 2022, from  
<https://www12.statcan.gc.ca/English/profil01/CP01/Details/Page.cfm?Lang=E&Geo1=CD&Code1=3524&Geo2=PR&Code2=35&Data=Count&SearchText=Halton+Regional+Municipality&SearchType=Begins&SearchPR=01&B1>All&GeoLevel=PR&GeoCode=3524&TABID=1>

Statistics Canada. (2007, March 13). 2006 community profiles - Census Division. Community Profiles from the 2006 Census, Statistics Canada - Census Division. Retrieved March 20, 2022, from  
<https://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CD&Code1=3524&Geo2=PR&Code2=35&Data=Count&SearchText=Halton&SearchType=Begins&SearchPR=01&B1>All&GeoLevel=PR&GeoCode=3524>

Statistics Canada. (2016, May 31). Census profile. Statistics Canada: Canada's national statistical agency / Statistique Canada : Organisme statistique national du Canada. Retrieved March 20, 2022, from  
<https://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CD&Code1=3524&Geo2=PR&Code2=35&Data=Count&SearchText=Halton&SearchType=Begins&SearchPR=01&B1>All&GeoLevel=PR&GeoCode=3524&TABID=1>

Statistics Canada. (2021, October 27). Census profile, 2016 census Halton, Regional Municipality [Census Division], Ontario and Ontario [Province]. Census Profile, 2016 Census - Halton, Regional municipality [Census division], Ontario and Ontario [Province]. Retrieved March 20, 2022, from  
<https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CD&Code1=3524&Geo2=PR&Code2=35&Data=Count&SearchText=Halton+Regional+Municipality&SearchType=Begins&SearchPR=01&B1>All&GeoLevel=PR&GeoCode=3524&TABID=1>

Statistics Canada. (2022, January 30). Census profile, 2021 census of Population data Table. Data table, Census Profile, 2021 Census of Population - Halton, Regional municipality (RM) [Census division], Ontario. Retrieved March 20, 2022, from  
<https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=Halton&DGUIDList=2021A00033524&GENDERlist=1&STATISTIClist=1&HEADERlist=0>