THE ROLE OF GEOGRAPHY IN DATA INTEGRATION AND PREDICTIVE ANALYTICS

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ENVIRONICS ANALYTICS

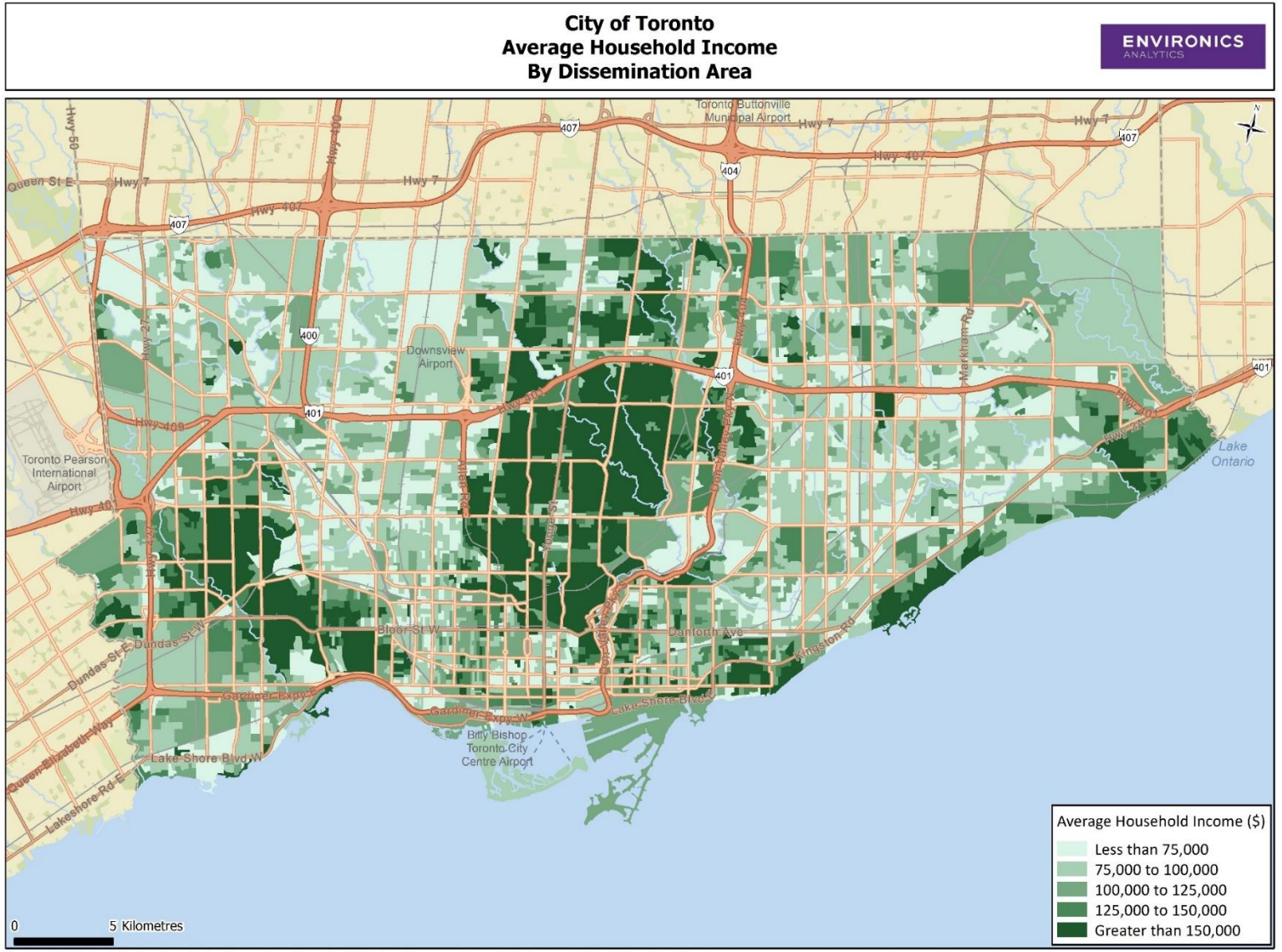
WHO AM I?

- Chief Methodologist and SVP at Environics Analytics
- Been there for its history – since 2003
- Involved in similar predecessor marketing data and analytics firms (e.g. Compusearch) since 1979
- BA, MA, Ph.D. - University of Toronto
- Taught at the University of Minnesota, University of Toronto, Queen's, Ryerson University
- Currently teach a graduate course on Geodemography at Ryerson University
- Presented about 400 papers at marketing and geography conferences

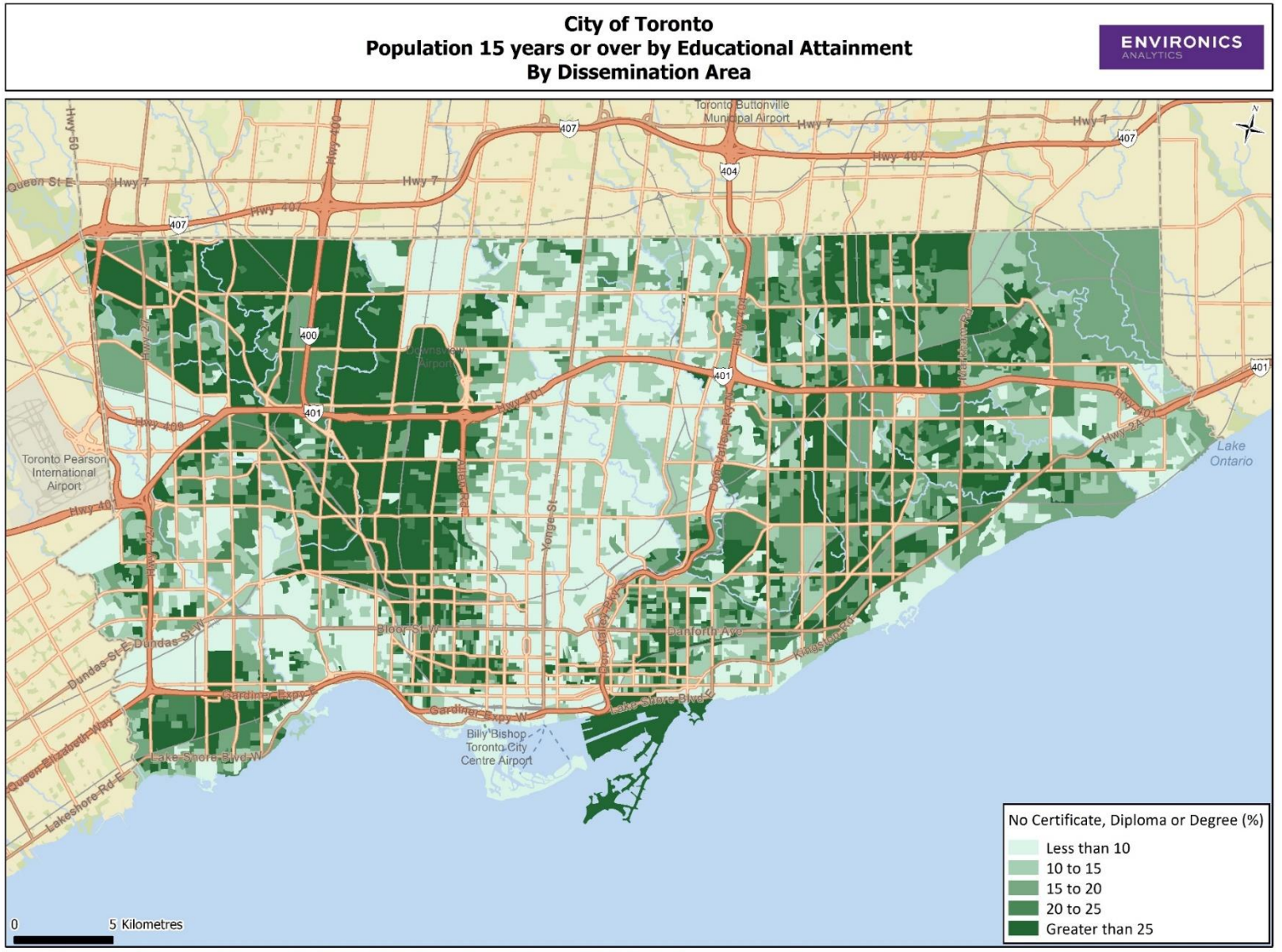
THIS TALK RELATES TO…

- How geography and spatial data can help to enhance predictive modelling practice
- Essentially - applied geography in terms data analytics
- Especially for marketing but not necessarily for marketing – as we will see
- Interesting that in North America this is not taught to geographers in university

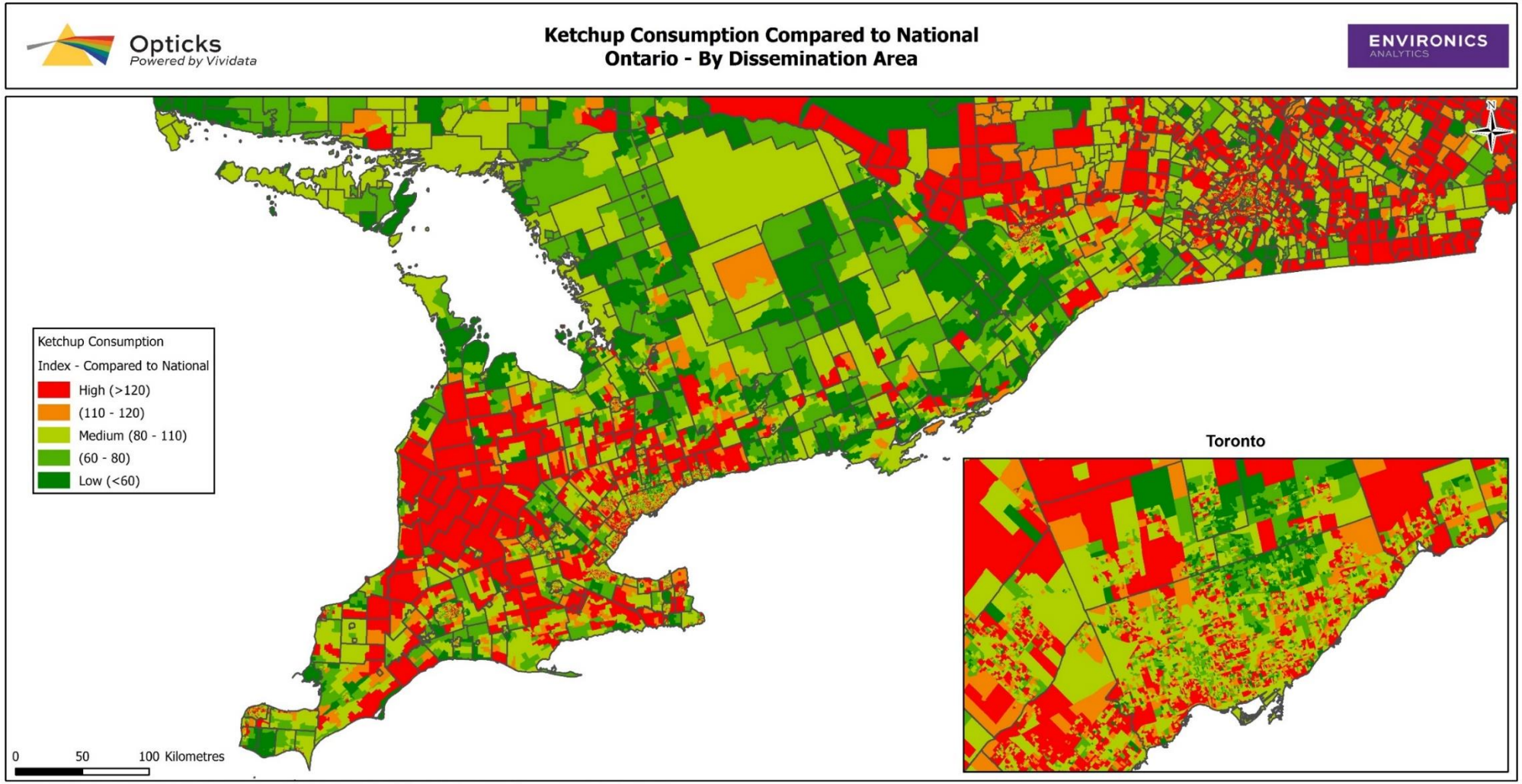
AVERAGE HOUSEHOLD INCOME IN TORONTO



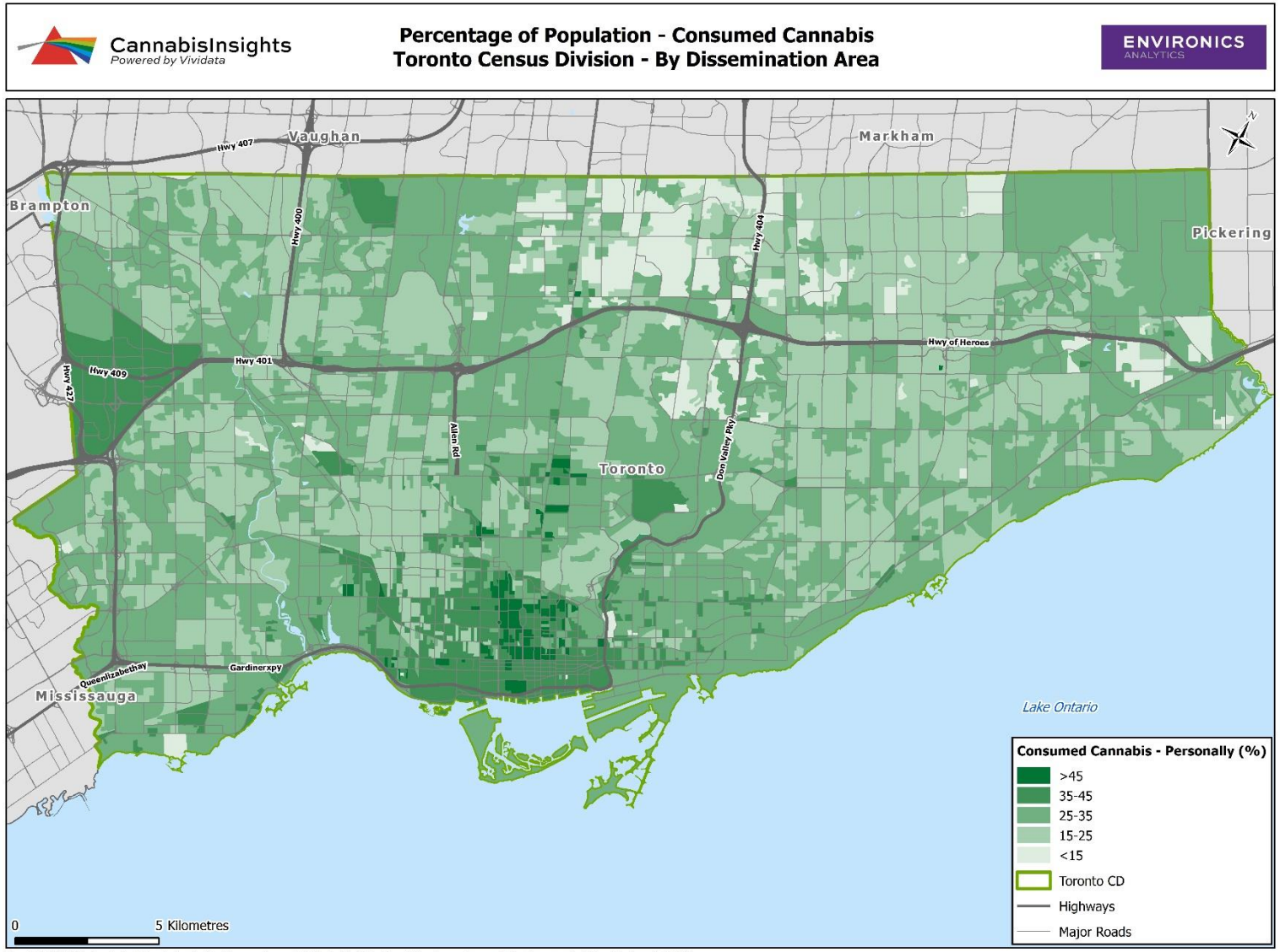
EDUCATION ATTAINMENT IN TORONTO



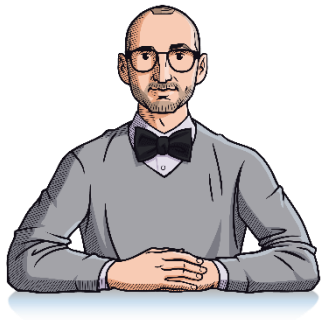
KETCHUP CONSUMPTION



TORONTONIANS WHO HAVE CONSUMED CANNABIS



ABOUT ENVIRONICS ANALYTICS

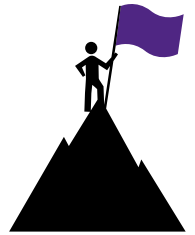


Founded in November 2003

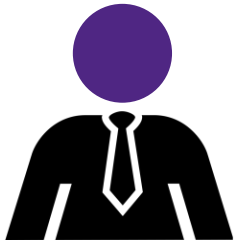
ENVIRONICS RESEARCH

Partnership with Environics Research Group

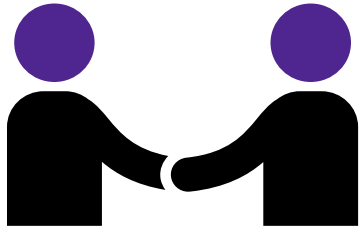
Specialists in data-driven insights and target marketing



Canada's largest marketing services provider



200+ employees strong



3,000+ customers across North America

Customer Advisory Board of 16 organizations

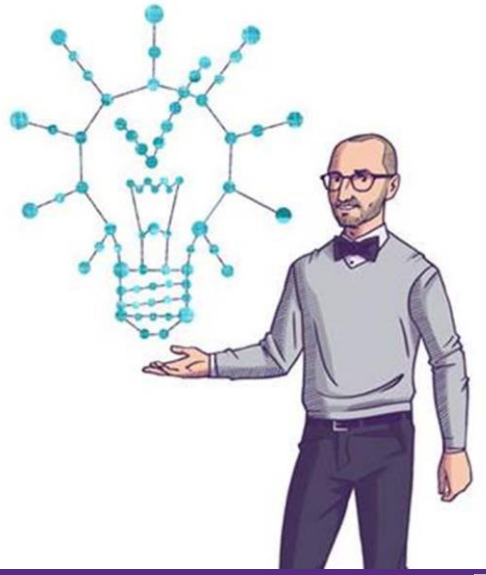
PRIZM5

Developers of PRIZM for Canada

OUR EXPERIENCE

We help clients achieve their business objectives by delivering actionable customer and market insight grounded in data and analytics.

- We have over 3,000 clients in every industry sector in North America including retail, finance, health, not for profit and government.



WHAT DATA IS TRADITIONALLY USED IN PREDICTIVE MODELLING?

- Extremely large data sets relating to human behaviour and interactions.
- Lots of data available today from many sources; the age of “BIG DATA”
- The data could be customer data, credit card data, and large syndicated survey data, twitter and other social media data etc.
- The focus in this talk is on individual or household data relating to demographics and behaviour: age, income, kids, shopping, travel, leisure, purchasing, donating, subscribing

THE CHALLENGE WITH THESE DATA

Because of privacy or small sample size, or both, a very large portion of these data cannot be **“really used”**

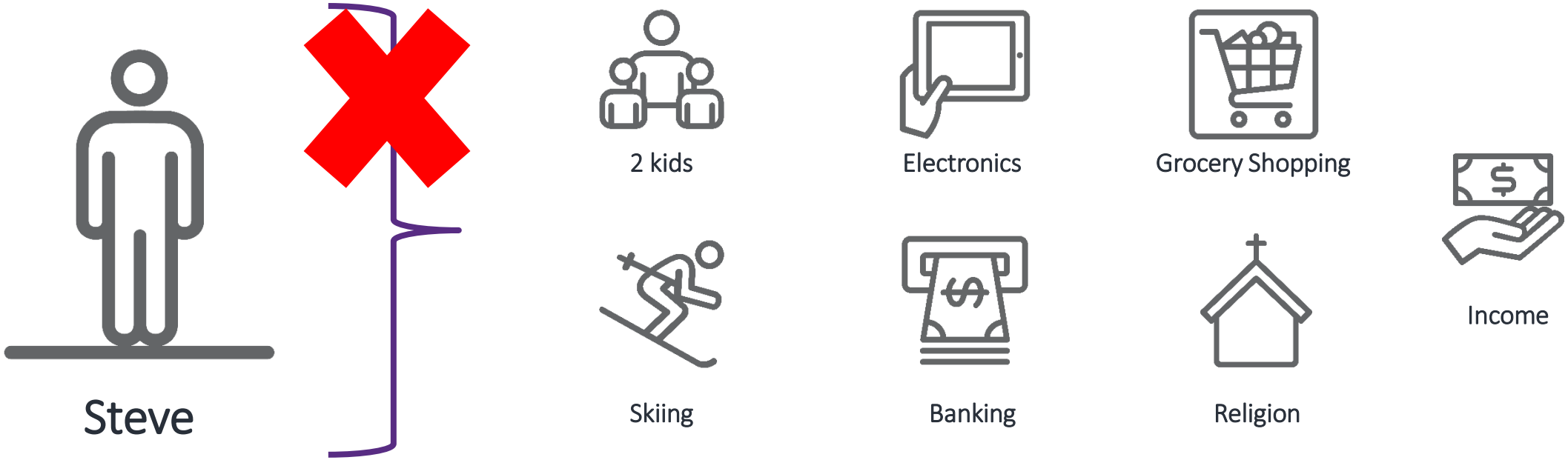
Privacy means inability to share or display names, phone numbers and other proprietary details

“Really used” means entered into an integrated data base and usable along with other data to draw conclusions

Unlike the past - much of these data now have a spatial reference (an address or postal code) – which can be used to aggregate data geographically

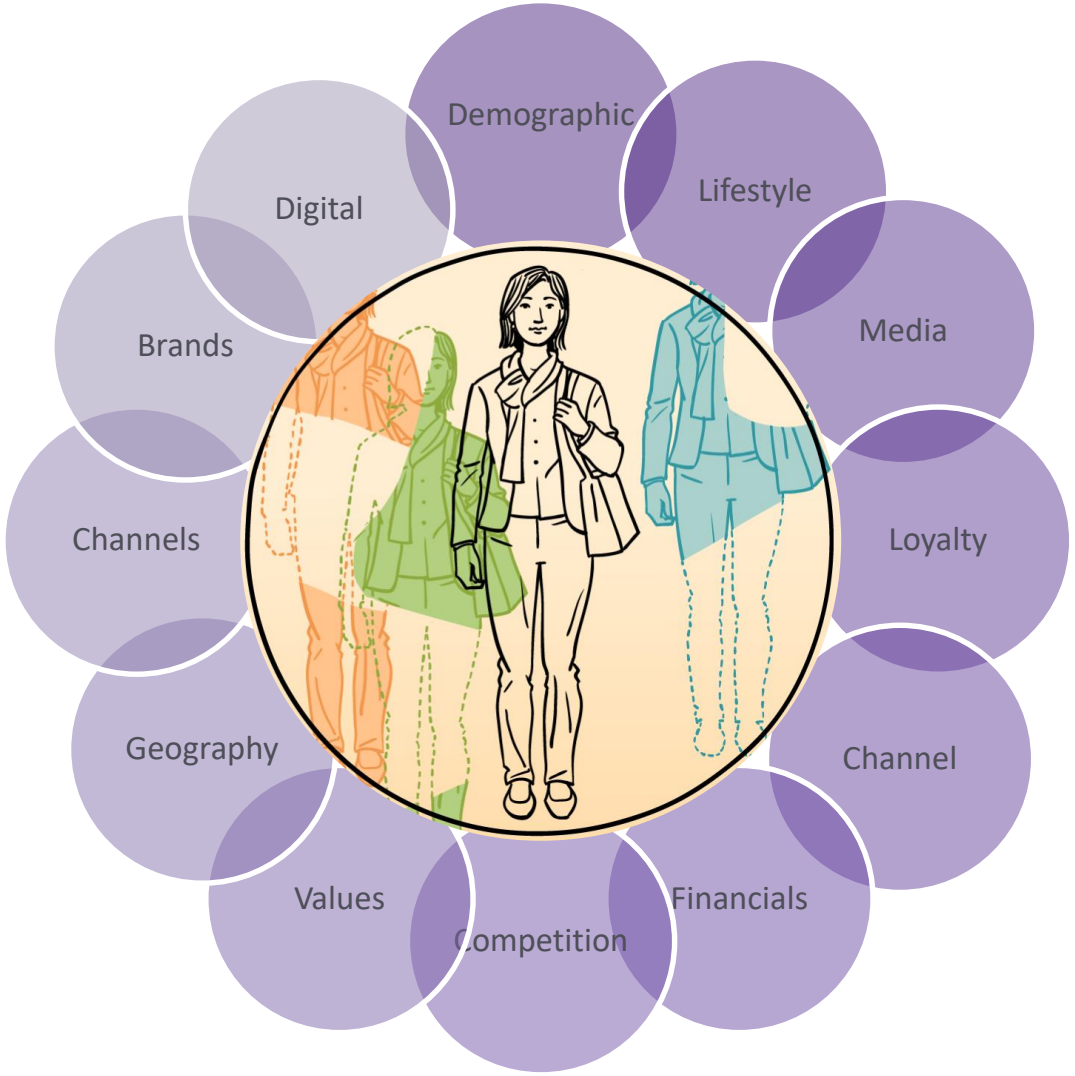
WHY ARE MUCH OF THESE DATA NOT USEFUL IN ANALYSIS?

- **They cannot be linked together to tell an integrated story**
- An integrated database requires that all the data relates to the same records, or observations (essential part of data integration)
- This permits statistical analysis and ability to act on the observations based on the results



CHALLENGES TO ONE VIEW OF THE CUSTOMER

- Legacy organizational silos that prevent enterprise-wide analytics
- Absence of analytical roadmaps linked to business strategy
- Methodology oversight is lacking or in the wrong hands



WHY ARE THESE DATA NOT USEFUL IN ANALYSIS?

- Need to find a way to assign these rich data (incomes, downhill ski rates etc.) **indirectly** to persons or households or to actual addresses for marketing somehow ... without breaking the privacy rules

- Since preparing and using **these individual data is not legal in Canada** under most circumstances - the challenge is clear.

- But there is a good approximation …

ENTER GEODEMOGRAPHICS

- Since about 1977 an industry has developed in Canada, and the UK, USA, etc. called geodemographics – also called micromarketing, customer analytics

- Here, demographics, socioeconomic, behavioural, and attitudinal data are integrated in datasets and analyzed, all done "geographically" - **Here geography becomes a tool for data integration**

- The major application areas are marketing of all kinds and retail site selection

- But there are also many other areas in public policy analysis, urban and regional planning, health care analysis, policing, tourism analysis, etc.

GEODEMOGRAPHY

- The geodemographic approach is based on **3 ideas**:

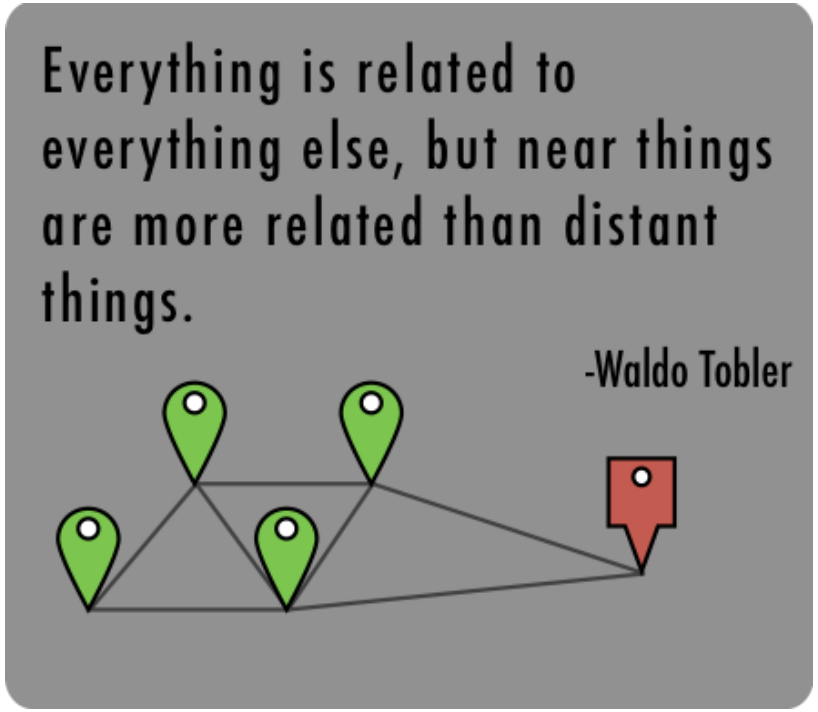
1. The first law of geography; the attributes of persons/households that are close together are more similar than those that are far away (*positive spatial autocorrelation*)

2. “Birds of a feather flock together”; so knowing a person’s neighbourhood (at a small spatial scale) helps make good inferences about the person

3. When privacy is critical, one can make use of small-area attributes as reasonable estimates of the attributes of residents of the small area

1. THE FIRST LAW OF GEOGRAPHY

The attributes of persons/households that are close together are more similar that those that are far away (positive spatial autocorrelation, Waldo Tobler)



2. BIRDS OF A FEATHER FLOCK TOGETHER

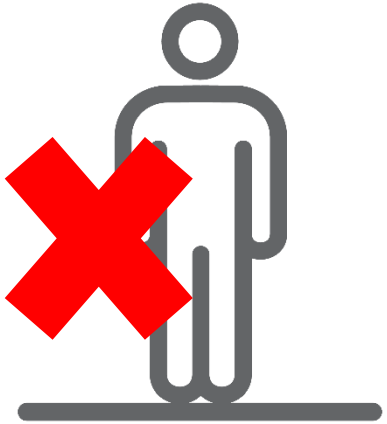
- This old adage, has considerable truth, especially in human geography
- Knowing a person's neighbourhood (at a small spatial scale) helps make good inferences about the person - in almost all contexts

3. PRESERVING PRIVACY

When privacy is critical one can make use of small-area attributes as reasonable estimates of the attributes of residents

GEODEMOGRAPHICS & PRIVACY

- Under most circumstances **data on persons/households can be shared in the form of aggregate data** - when assigned to small geographical areas; this is what the census does
- This is done for all small and larger census areas: Dissemination Areas (DA), Census Tracts (CT) and postal areas like Forward Sortation Areas (FSAs), and also FSALDU's – 6 character postal codes.



Steve

10 to 50 people + Steve

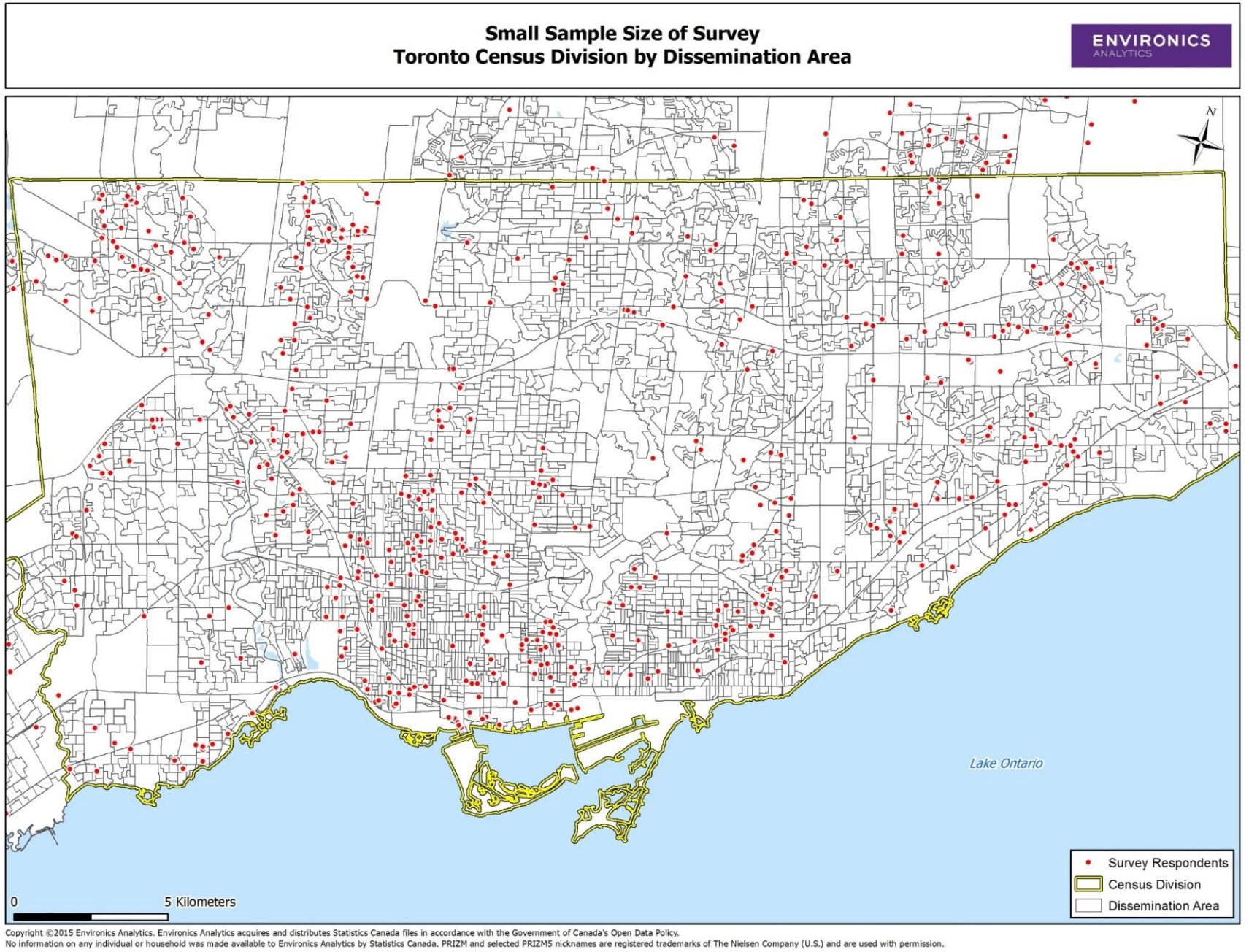
QUESTIONS ADDRESSED BY GEODEMOGRAPHICS

The basic questions of geodemography are:

1. What are the attributes of or the segment for this particular small area (e.g. census area)?
2. What is the profile of a specific set of customers/subscribers/donors/patients in a database?
3. Where can I find more of these types of persons and households?
4. What is the profile of a particular market or trade area?
5. What is the profile of surveyed persons who buy X or prefer Y (yoga, shop at Walmart, eat donuts every day, vacation in Barbados, buy Tide detergent, go canoeing)?

SMALL SAMPLE (SURVEY) DATA

- What if the set of observations (customers, surveyed persons) is less than the number of small neighbourhoods? (.68 respondents per area)
  - *The small sample problem*
- Small census areas have a certain average household income, a certain distribution of ages, household sizes, types of dwellings, ethnicities etc. These data are published by Stats Canada routinely and are widely used
- If we are interested in hip replacement patients, ketchup consumption, blue box use, or Lexus buyers? What if – as usual - we have just survey data? In these cases the number of data points is usually small?
- How do we proceed with analysis and the making of helpful inferences?



Sample survey locations of respondents - a relatively small sample of points

HOW CAN WE HANDLE THESE DATA ?

- This map is difficult to generalize and to analyze (we could cartographically “smooth the map”)
- The number of Dissemination Areas (DAs) in Ontario is just over 20,000 so the number of survey respondents in Ontario almost always be much smaller
  - So less than one respondent per DA
- So we cannot create a meaningful DA-level database to analyze statistically, and we cannot map it as a thematic or choropleth map

This is a problem. We have good data, it is geographically referenced, but a good deal of analysis is impossible.

SOLUTIONS

Solution 1 (this is what was done before about 1983)

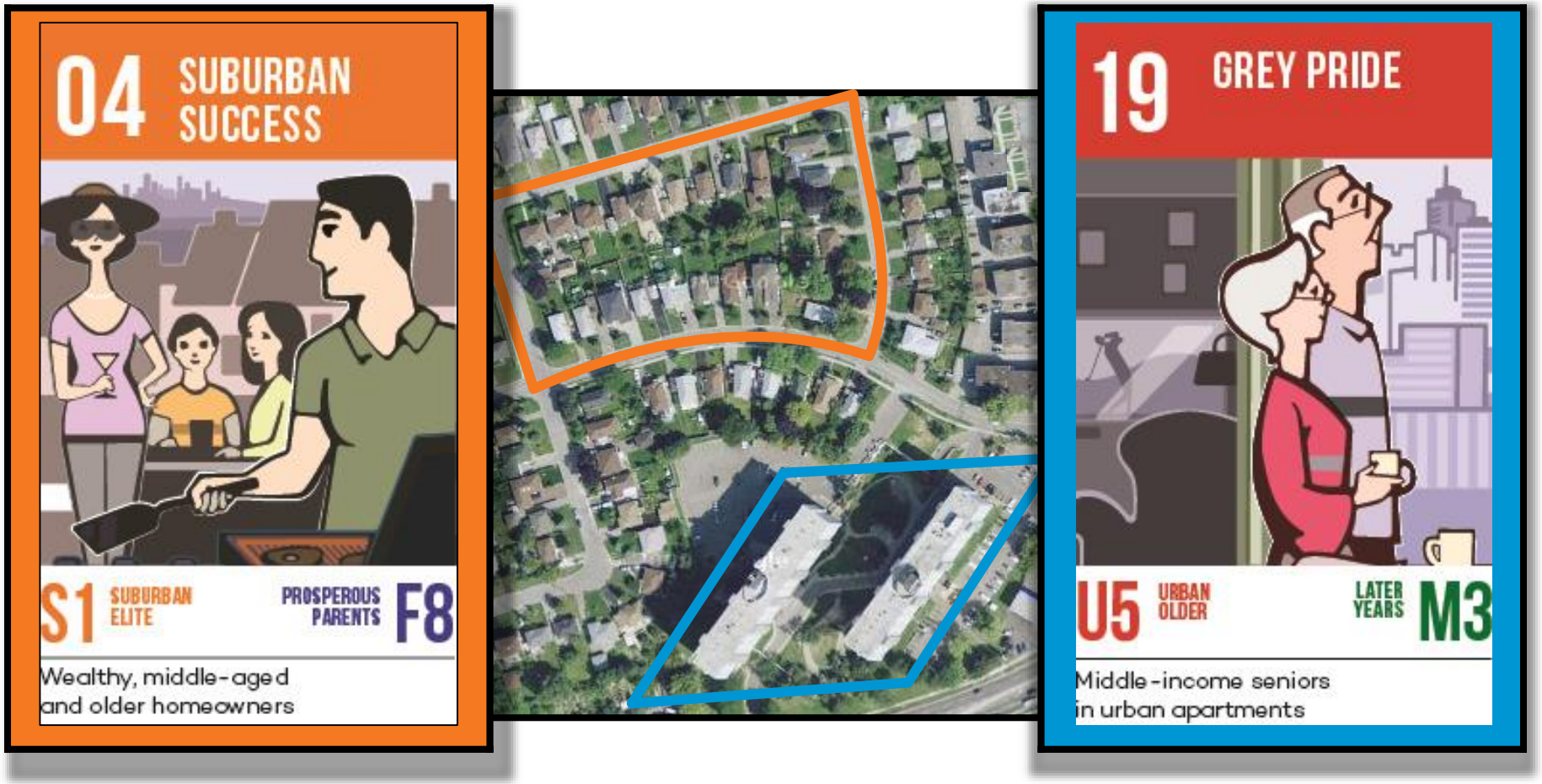
- Run a **regression** (or similar model) on the density per household of the behaviour using the small areas (such as dissemination areas) as observations:
  - Downhill ski rate = 0.068 + 0.0025 * (Income) - 0.027 * (% age 55 plus) + …

Solution 2 (use a segmentation system - like Environics Analytics PRIZM5)

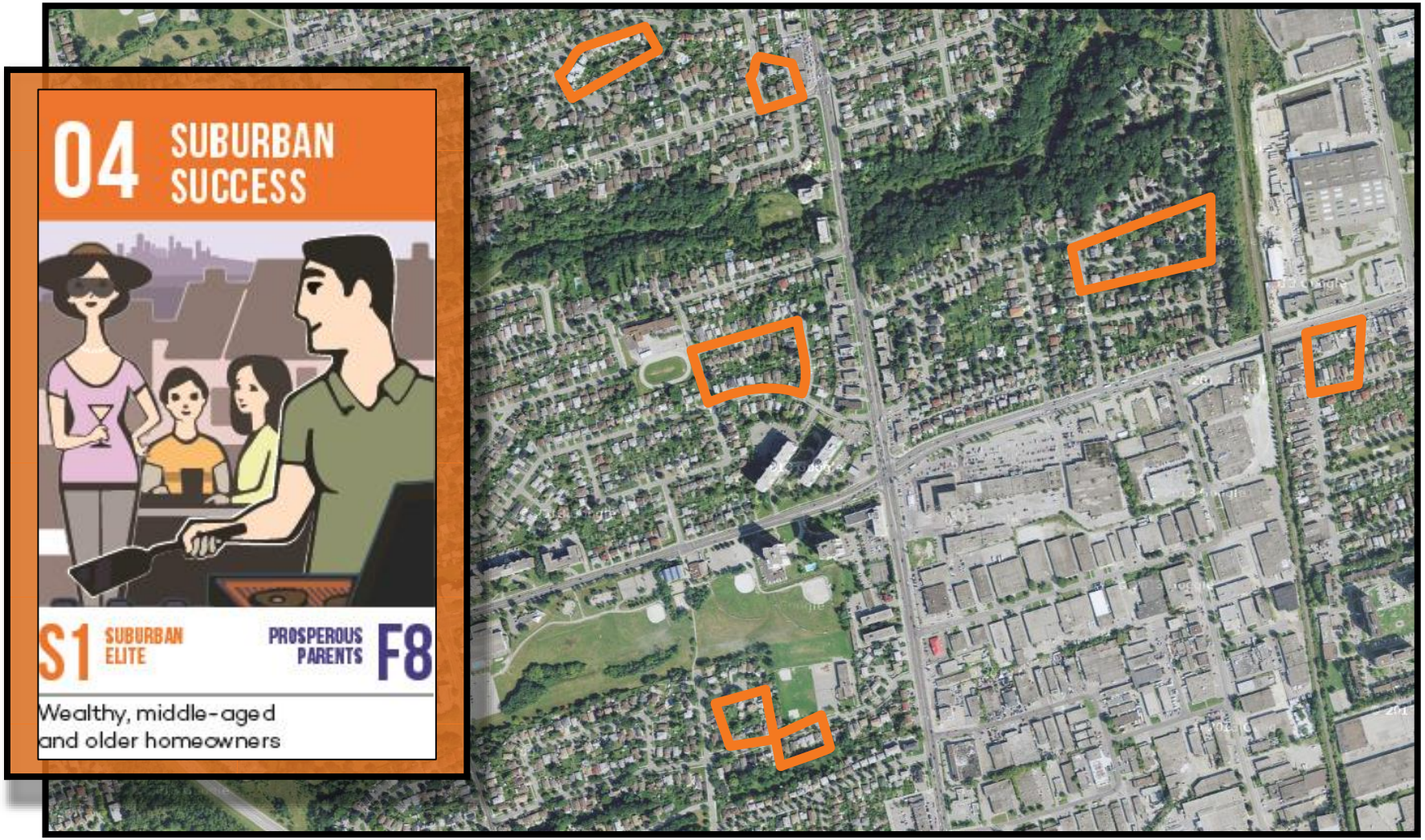
- EAG has developed a segmentation system (PRIZM5) for small areas based on demographics, socioeconomics, urbanity, density and some behaviour
- PRIZM5 classifies all Canadian neighbourhoods into 68 unique segments
- In this approach we create an **analysis database** of these 68 segments
- It includes rates of buying or preferring X (or penetration rates)
- We then analyze and map the segments at a small geographical scale - not at the persons/households level

GEODEMOGRAPHIC SEGMENTATION

WE CAN THEN ASSIGN LIFESTYLES TO NEIGHBOURHOODS



...AND FIND THESE LIFESTYLES ALL OVER CANADA



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EXAMPLE: LOCATING 3 SEGMENTS IN THE GTA

45-64

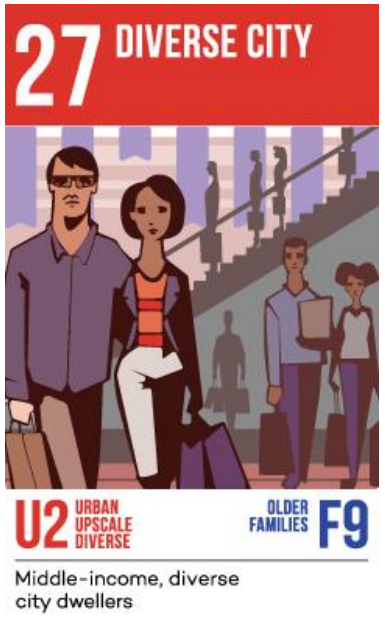
$88,609

Mixed Education

Majority Chinese

Yoga

Asian Restaurants



Over 55

$85,204

High School

Multicultural

Soccer Games

Pizza Pizza

25-45

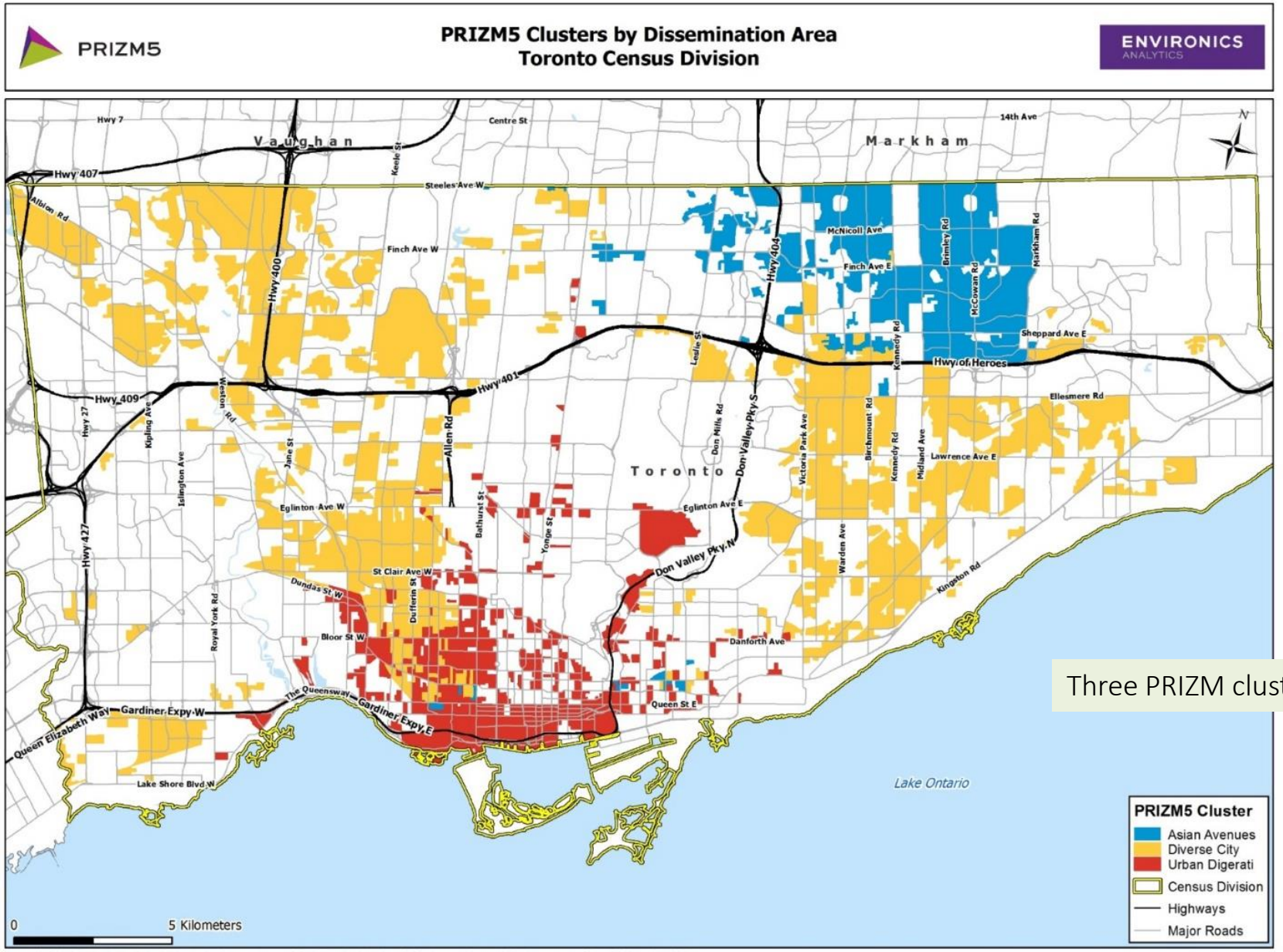
$105,803

University

Multicultural

Online Dating

David's Tea



Three PRIZM clusters mapped in Toronto

ILLUSTRATION OF APPROACH 2

- The following is a very simple example that illustrates the idea
- It is a worked example of participation in downhill skiing using a small database – shown here as an Excel file
- The survey data come from a well known Canadian large syndicated survey

Glimpse of a Survey Database

Respondents	PRCDDA	PRCDCSD	CMA CA	Downhill Skiing in the last year	Own Ski Equipment	Watch Skiing Television	Attend Outdoor Shows/Exhibitions	Travelled on Skiing Holiday
M1M2L4	35204207	3520005	535	0	0	0	0	0
M4N2T7	35202348	3520005	535	1	1	0	1	1
M4X1S5	35200796	3520005	535	0	0	0	0	0
M1V2N5	35200128	3520005	535	0	0	0	0	0
M3B3J9	35202764	3520005	535	1	1	0	1	1
M2H1V2	35202462	3520005	535	1	1	0	1	1
M6S1P5	35203153	3520005	535	0	0	0	0	0
M2P1C3	35202614	3520005	535	1	1	1	1	1
M6N2Z1	35201168	3520005	535	0	0	0	0	0
M8X2K5	35201501	3520005	535	1	1	0	0	1
M4G2Z9	35202769	3520005	535	1	1	1	0	1
M9B4N2	35201649	3520005	535	0	0	0	0	0
M6N4S8	35201242	3520005	535	0	0	0	0	0
M4G1N7	35202685	3520005	535	0	0	0	0	0
M2P0A1	35202614	3520005	535	1	1	1	0	1
M4L3R7	35200667	3520005	535	0	0	0	0	0
M4W1W6	35202879	3520005	535	1	0	1	0	1
M2H2M7	35202477	3520005	535	1	1	1	1	0
M2P1G1	35202616	3520005	535	1	1	0	0	1
M4J2P2	35203864	3520005	535	0	0	0	0	0
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A small piece of a customer database or a large (N=5000) syndicated survey

Survey Database - PRIZM5 Cluster Field Appended

Respondents	PRCDDA	PRCDCSD	CMA CA	Downhill Skiing in the last year	Own Ski Equipment	Watch Skiing Television	Attend Outdoor Shows/Exhibitions	Travelled on Skiing Holiday	PRIZM5	NAME
M1M2L4	35204207	3520005	535	0	0	0	0	0	28	Metro Multiculturals
M4N2T7	35202348	3520005	535	1	1	0	1	1	01	Cosmopolitan Elite
M4X1S5	35200796	3520005	535	0	0	0	0	0	03	Arts & Affluence
M1V2N5	35200128	3520005	535	0	0	0	0	0	13	Asian Avenues
M3B3J9	35202764	3520005	535	1	1	0	1	1	01	Cosmopolitan Elite
M2H1V2	35202462	3520005	535	1	1	0	1	1	13	Asian Avenues
M6S1P5	35203153	3520005	535	0	0	0	0	0	12	Street Scenes
M2P1C3	35202614	3520005	535	1	1	1	1	1	01	Cosmopolitan Elite
M6N2Z1	35201168	3520005	535	0	0	0	0	0	27	Diverse City
M8X2K5	35201501	3520005	535	1	1	0	0	1	01	Cosmopolitan Elite
M4G2Z9	35202769	3520005	535	1	1	1	0	1	11	Urban Digerati
M9B4N2	35201649	3520005	535	0	0	0	0	0	28	Metro Multiculturals
M6N4S8	35201242	3520005	535	0	0	0	0	0	27	Diverse City
M4G1N7	35202685	3520005	535	0	0	0	0	0	01	Cosmopolitan Elite
M2P0A1	35202614	3520005	535	1	1	1	0	1	01	Cosmopolitan Elite
M4L3R7	35200667	3520005	535	0	0	0	0	0	03	Arts & Affluence
M4W1W6	35202879	3520005	535	1	0	1	0	1	01	Cosmopolitan Elite
M2H2M7	35202477	3520005	535	1	1	1	1	0	13	Asian Avenues
M2P1G1	35202616	3520005	535	1	1	0	0	1	01	Cosmopolitan Elite
M4J2P2	35203864	3520005	535	0	0	0	0	0	11	Urban Digerati
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Each DA in Canada has an assigned PRIZM5 code

File Sorted: Cluster 01 Rate Creation

Respondents	PRCDDA	PRCDCSD	CMA CA	Downhill Skiing in the last year	Own Ski Equipment	Watch Skiing Television	Attend Outdoor Shows/Exhibitions	Travelled on Skiing Holiday	PRIZM5	NAME
M4N2T7	35202348	3520005	535	1	1	0	1	1	01	Cosmopolitan Elite
M3B3J9	35202764	3520005	535	1	1	0	1	1	01	Cosmopolitan Elite
M2P1C3	35202614	3520005	535	1	1	1	1	1	01	Cosmopolitan Elite
M8X2K5	35201501	3520005	535	1	1	0	1	1	01	Cosmopolitan Elite
M4G1N7	35202685	3520005	535	1	0	0	0	0	01	Cosmopolitan Elite
M2P0A1	35202614	3520005	535	1	1	1	0	1	01	Cosmopolitan Elite
M4W1W6	35202879	3520005	535	1	1	1	0	1	01	Cosmopolitan Elite
M2P1G1	35202616	3520005	535	1	1	0	0	1	01	Cosmopolitan Elite
M8X2C7	35201504	3520005	535	0	0	0	0	0	01	Cosmopolitan Elite
M5P3A6	35202896	3520005	535	1	0	0	0	0	01	Cosmopolitan Elite
M4R1X5	35202341	3520005	535	1	1	1	1	1	01	Cosmopolitan Elite
M5M2J6	35202363	3520005	535	1	1	1	1	1	01	Cosmopolitan Elite
M2L2G6	35202622	3520005	535	1	0	0	0	1	01	Cosmopolitan Elite
M2L1W2	35200371	3520005	535	1	1	0	0	1	01	Cosmopolitan Elite
M4W2Z5	35203848	3520005	535	1	0	0	0	1	01	Cosmopolitan Elite
M5P1G8	35202905	3520005	535	0	0	0	0	0	01	Cosmopolitan Elite
M4T1J6	35202776	3520005	535	0	0	0	0	0	01	Cosmopolitan Elite
M4N3J6	35204201	3520005	535	1	0	0	0	1	01	Cosmopolitan Elite
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		Rate >		0.733	0.500	0.333	0.400	0.633		

Sort DB by cluster code and focus on one cluster as an example.
All the records here are those classed in cluster 1

Cluster 01 - Cosmopolitan Elites
Toronto Census Division by Dissemination Area

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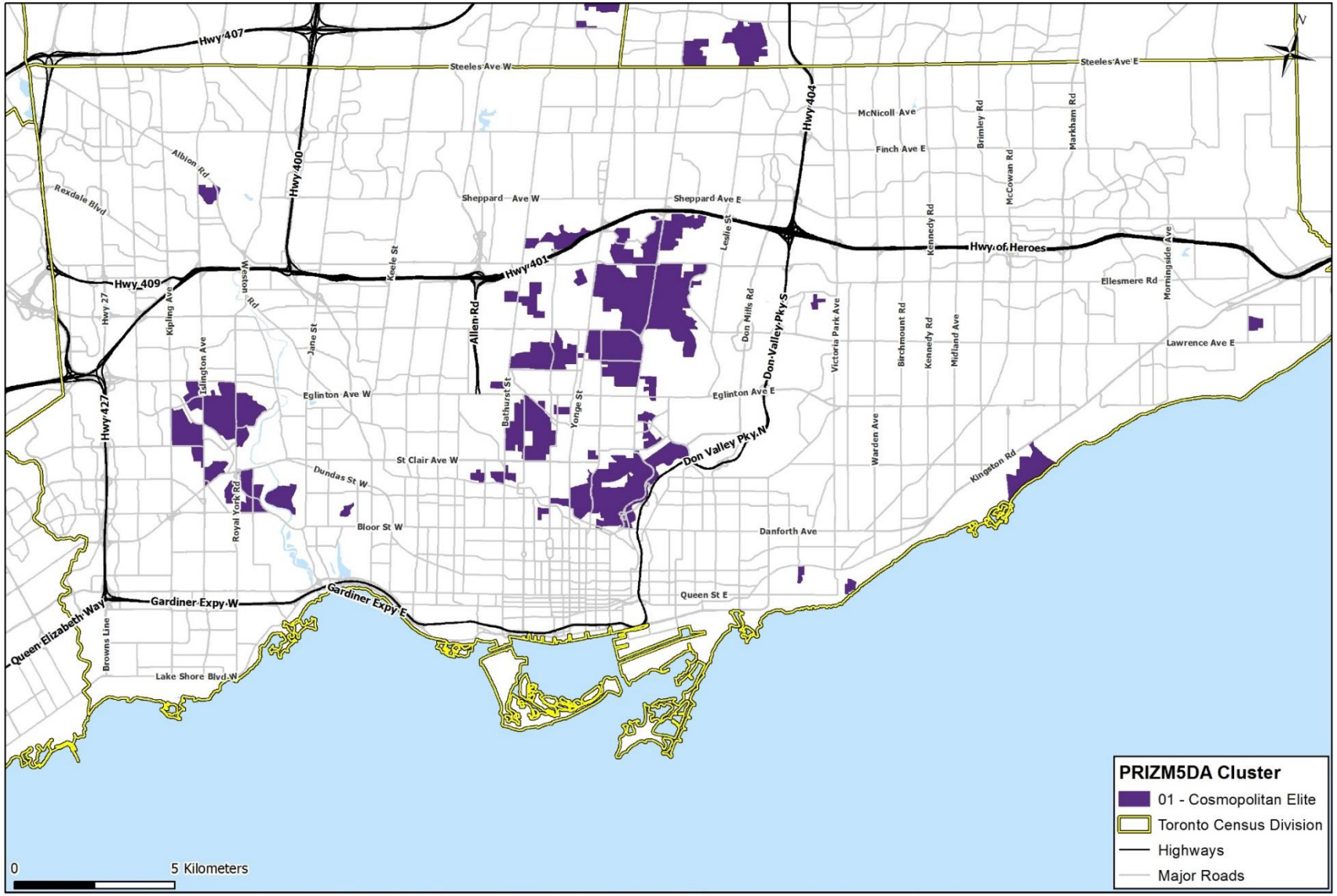

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Cluster 01 Cosmopolitan Elites - Downhill Skiing Rates
Toronto Census Division by Dissemination Area

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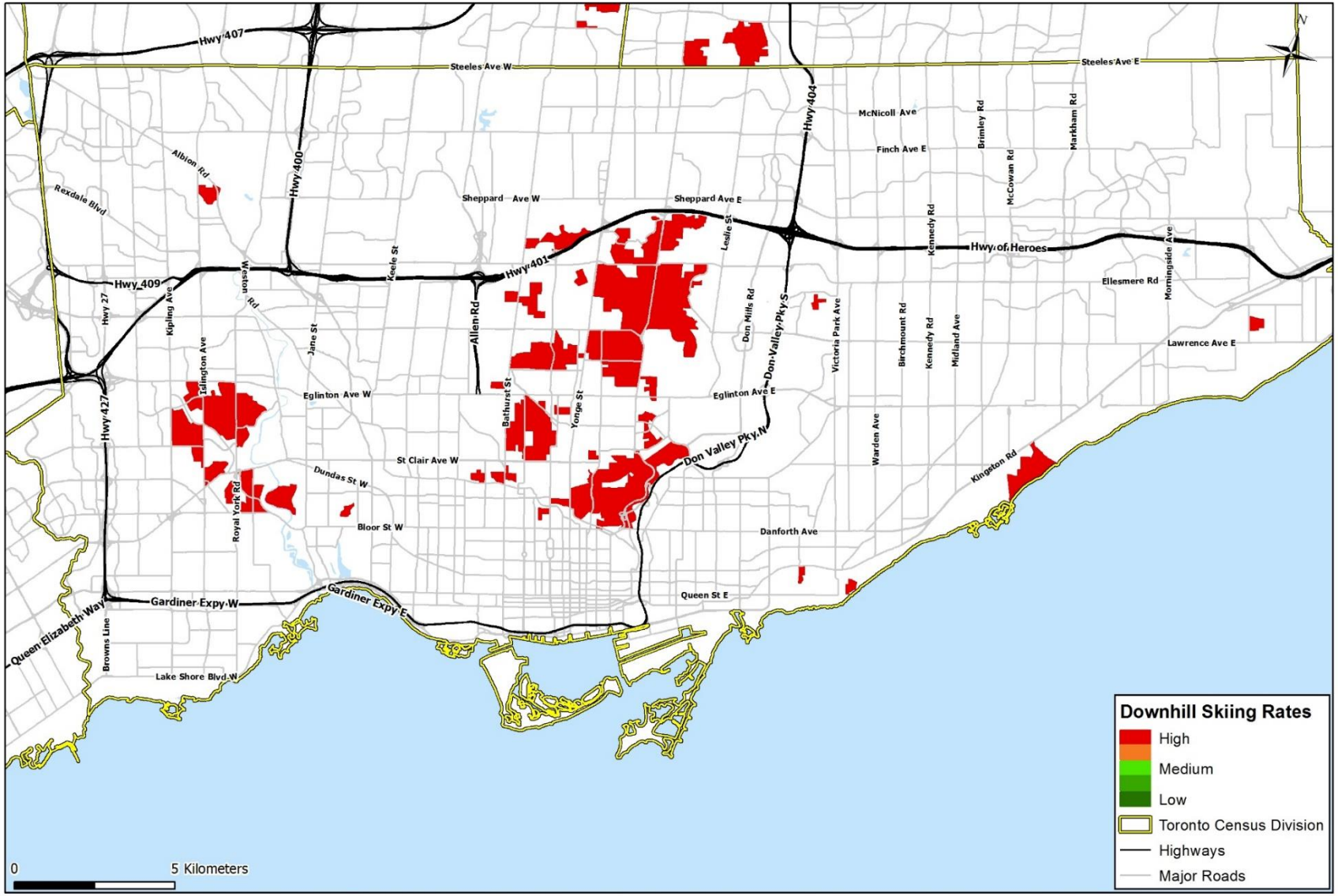

Final Cluster Rates

PRIZM5	NAME	Downhill Skiing in the last year Rate	Own Ski Equipment Rate	Watch Skiing Television Rate	Attended Outdoor Shows/Exhibitions Rate	Travelled on Skiing Holiday Rate
01	Cosmopolitan Elite	0.733	0.500	0.333	0.400	0.633
02	Urbane Villagers	0.603	0.565	0.207	0.232	0.599
03	Arts & Affluence	0.655	0.456	0.051	0.344	0.466
04	Suburban Success	0.433	0.400	0.032	0.500	0.245
05	Asian Sophisticates	0.255	0.052	0.065	0.344	0.223
06	Kids & Careers	0.415	0.220	0.317	0.195	0.195
08	Boomerang City	0.134	0.040	0.033	0.033	0.055
10	Emptying Nests	0.010	0.000	0.065	0.075	0.025
11	Urban Digerati	0.480	0.249	0.249	0.249	0.220
12	Street Scenes	0.433	0.224	0.216	0.202	0.204
13	Asian Avenues	0.451	0.207	0.207	0.231	0.225
14	Diversity Heights	0.000	0.000	0.000	0.000	0.000
15	Heritage Hubs	0.000	0.000	0.000	0.000	0.000
16	Pets & PCs	0.355	0.299	0.120	0.125	0.150
18	Management Material	0.091	0.091	0.091	0.182	0.091
19	Grey Pride	0.167	0.000	0.000	0.167	0.000
20	South Asian Achievers	0.056	0.000	0.111	0.111	0.167
22	Aging in Suburbia	0.000	0.000	0.000	0.000	0.000
23	Asian New Wave	0.045	0.045	0.000	0.000	0.000
24	Fresh Air Families	0.000	0.000	0.000	0.000	0.000
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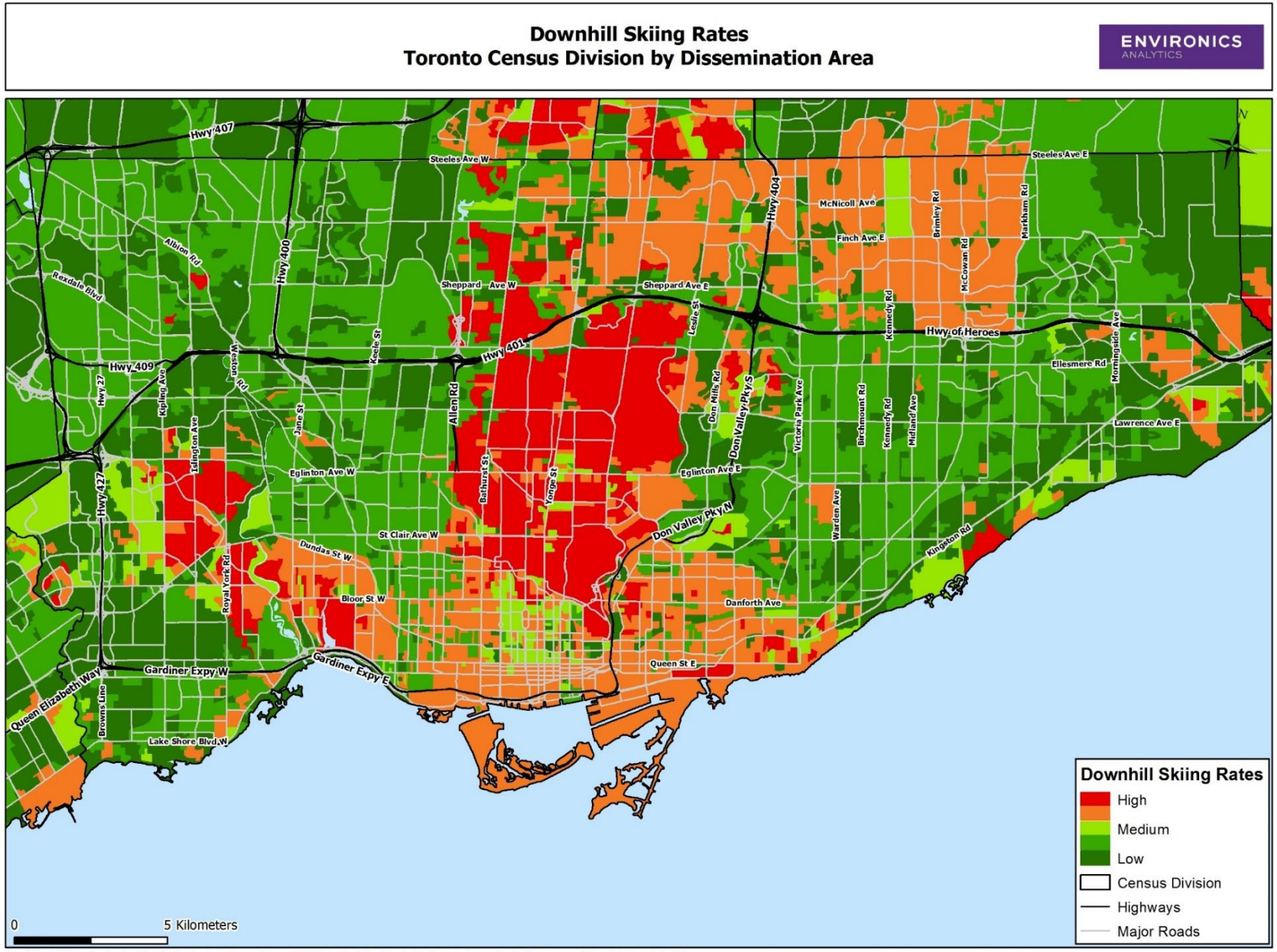
High

Low

Rates then created for all 68 segments in exactly the way described above



A choropleth map of all DAs downhill skiing participation rates based on their PRZM5 rates

Final Cluster Rates

PRIZM5	NAME	Downhill Skiing in the last year Rate	Own Ski Equipment Rate	Watch Skiing Television Rate	Attended Outdoor Shows/Exhibitions Rate	Travelled on Skiing Holiday Rate
01	Cosmopolitan Elite	0.733	0.500	0.333	0.400	0.633
02	Urbane Villagers	0.603	0.565	0.207	0.232	0.599
03	Arts & Affluence	0.655	0.456	0.051	0.344	0.466
04	Suburban Success	0.433	0.400	0.032	0.500	0.245
05	Asian Sophisticates	0.255	0.052	0.065	0.344	0.223
06	Kids & Careers	0.415	0.220	0.317	0.195	0.195
08	Boomerang City	0.134	0.040	0.033	0.033	0.055
10	Emptying Nests	0.010	0.000	0.065	0.075	0.025
11	Urban Digerati	0.480	0.249	0.249	0.249	0.220
12	Street Scenes	0.433	0.224	0.216	0.202	0.204
13	Asian Avenues	0.451	0.207	0.207	0.231	0.225
14	Diversity Heights	0.000	0.000	0.000	0.000	0.000
15	Heritage Hubs	0.000	0.000	0.000	0.000	0.000
16	Pets & PCs	0.355	0.299	0.120	0.125	0.150
18	Management Material	0.091	0.091	0.091	0.182	0.091
19	Grey Pride	0.167	0.000	0.000	0.167	0.000
20	South Asian Achievers	0.056	0.000	0.111	0.111	0.167
22	Aging in Suburbia	0.000	0.000	0.000	0.000	0.000
23	Asian New Wave	0.045	0.045	0.000	0.000	0.000
24	Fresh Air Families	0.000	0.000	0.000	0.000	0.000
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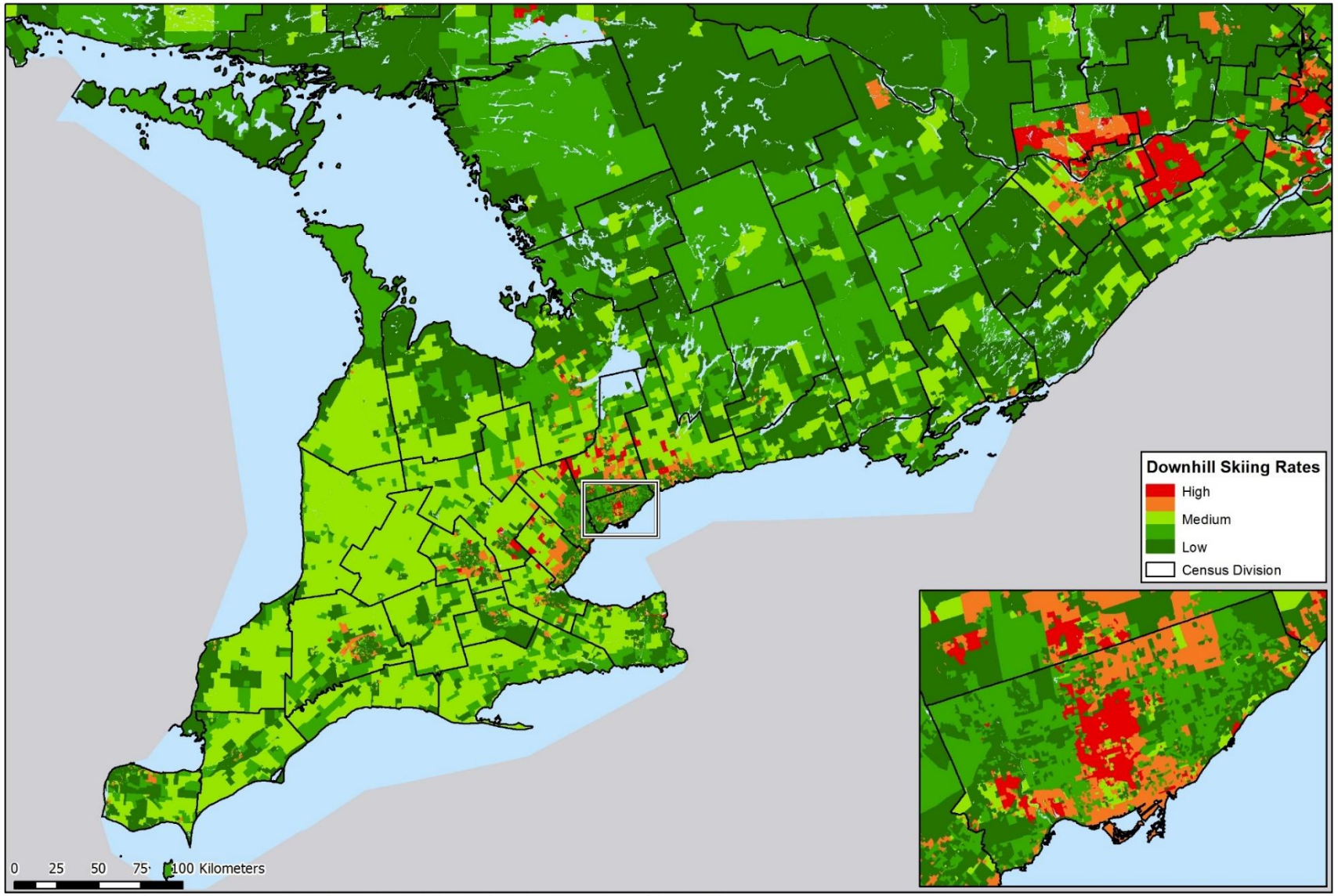
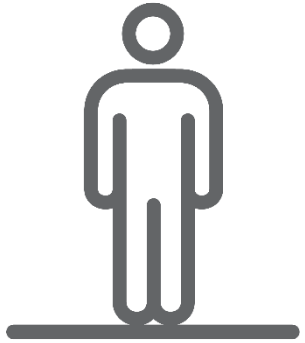
Downhill Skiing Rates
Southern Ontario by Dissemination Area



OTHER USES: RETAIL SITE SELECTION

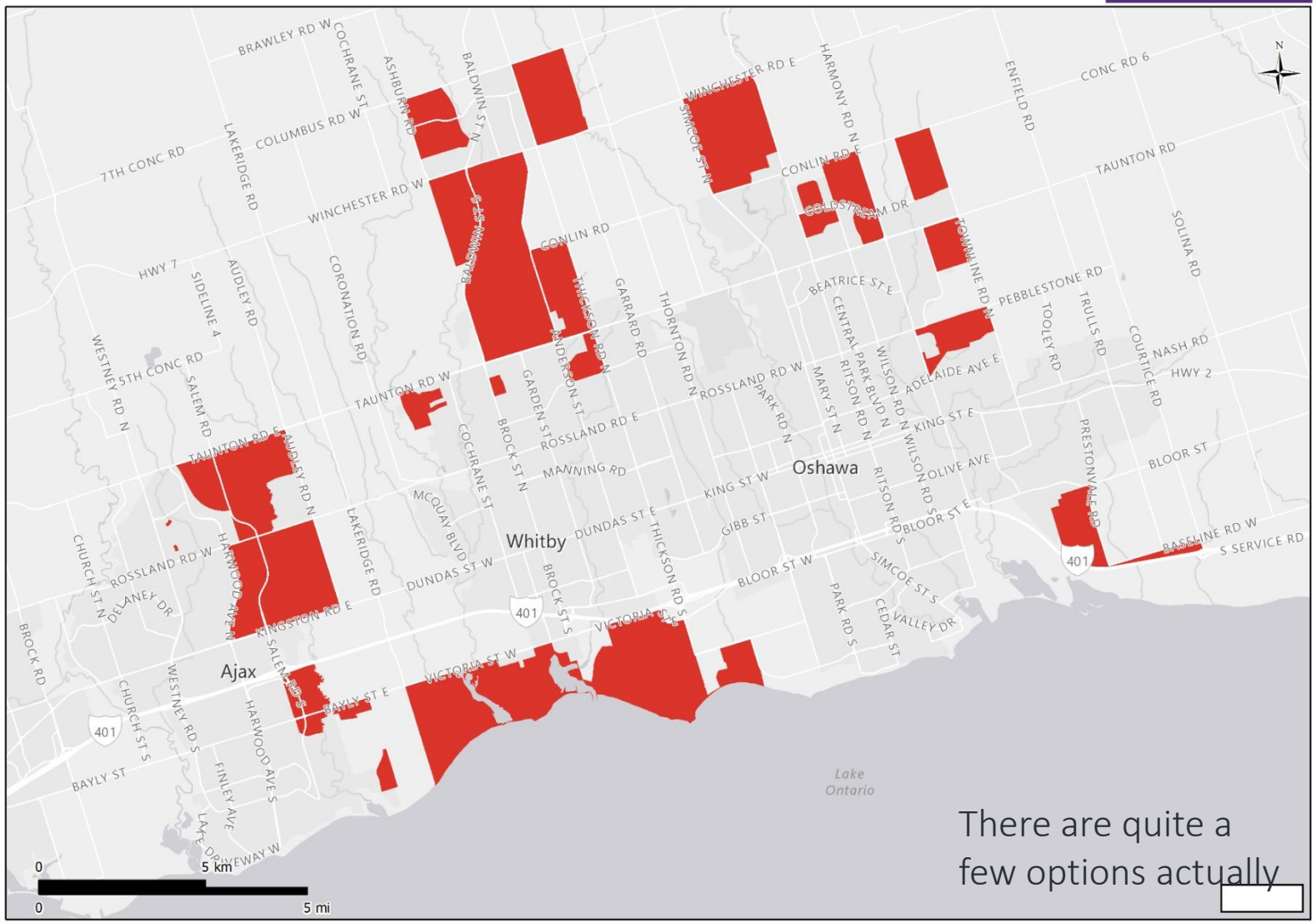
- Lets say that a local retailer is looking to expand to a new location in Durham Region
- They analyze their data and find that Steve and others in similar neighbourhoods are the highest spending and most loyal patrons in their database
- To proceed they should “profile” Steve and colleagues using PRIZM5 and try to find neighbourhoods with people like Steve
- Then select a location that is nearby



Steve

People Like Steve

Durham Region



There are quite a few options actually

Variable Description: Target Sets

THE ECOLOGICAL FALLACY – A POSSIBLE DOWNSIDE

- This geodemographic approach is becoming more important in a BIG DATA world focused on analytics and concerned with privacy
- **However**, the approach can yield erroneous inferences because of the celebrated problem called the "**ecological fallacy**" and this should be researched more
- The fallacy is: "because a small area, or a small group, behaves like X on the average, that all persons in the set behave like X"
- In the marketing realm researchers have found that the fallacy occurs, but it occurs infrequently ... and is weak
  - This means that if an area behaves like X on average *that most people or households* from this area generally behave like X
- **Leveraging the geodemographic approach is a critical tool for marketers and many other purposes**

THE SEGMENTS NEED TO MAKE SENSE

- To feel comfortable about a simple cluster-based approach requires that users believe that the clusters/segments make sense as a classification system for the behaviour or purpose being studied
- The EA PRIZM5 segments were developed as general purpose market segments using: Census demographic and socioeconomic data, geographical context data, and some behavioural data and are updated annually based on new data
- Other countries have similar geodemographic segmentation systems

acxiom Personicx®

mosaic USA

Experian Mosaic

Synergos

mosaic™ Greece

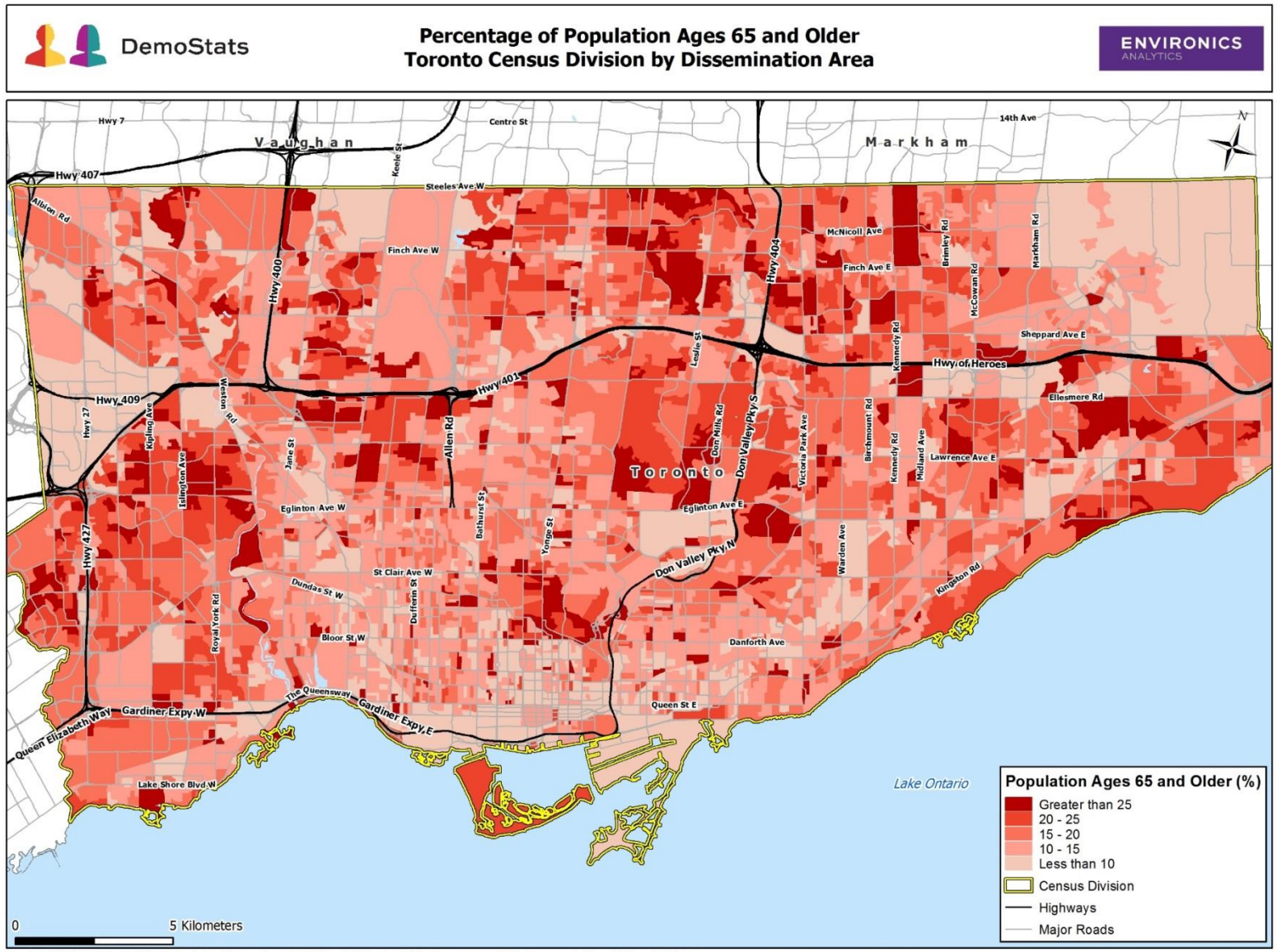
…NOW FOR SOME MORE FUN MAPS

- Let's quickly look at the kinds of maps that geodemographers and GIS analysts create and view each day

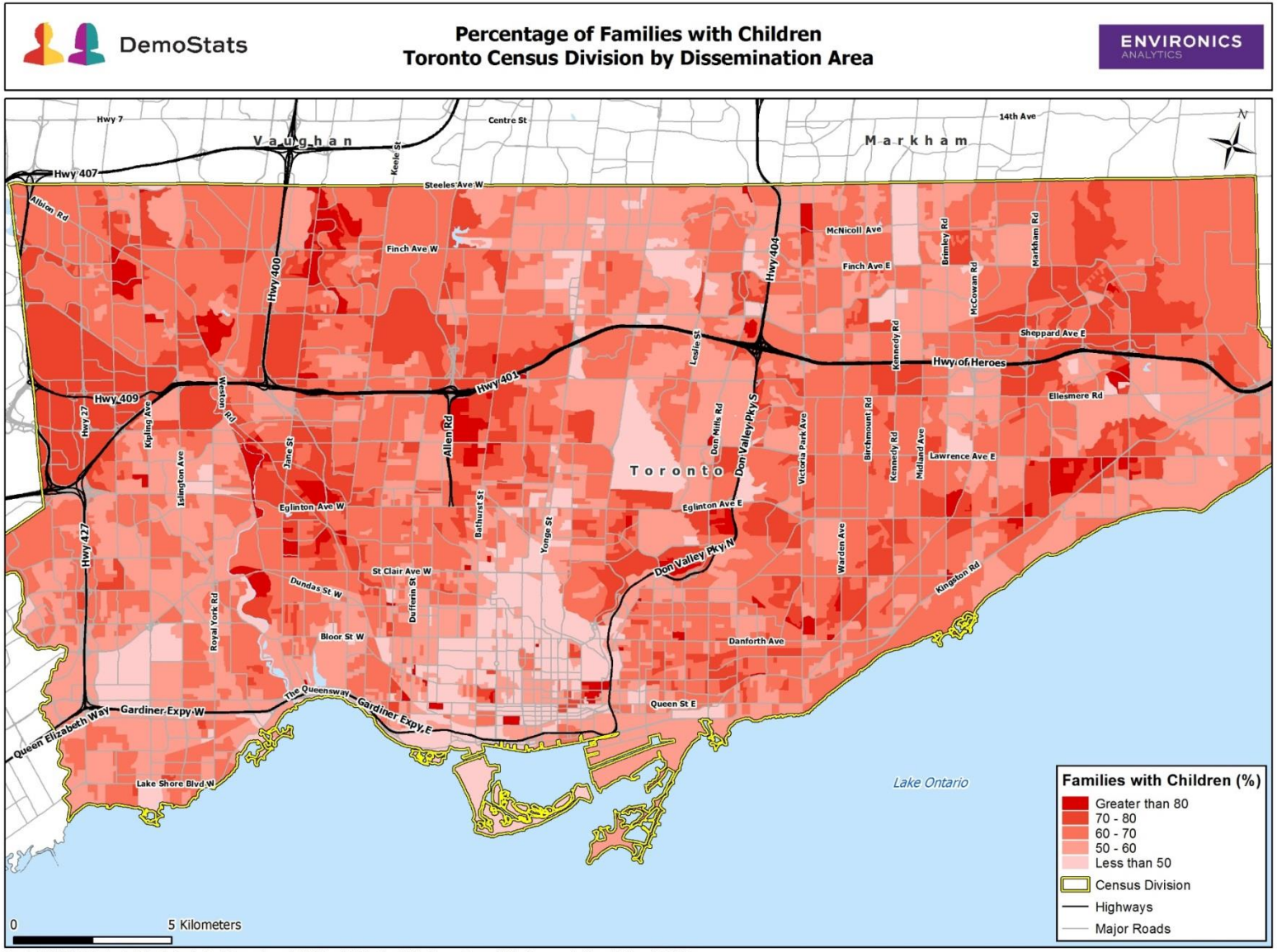
- First I show a few maps of interesting census-like socioeconomic and demographic variables

- Helpful in marketing research in understanding how these variables and trends can be used for estimating who likes certain products and services

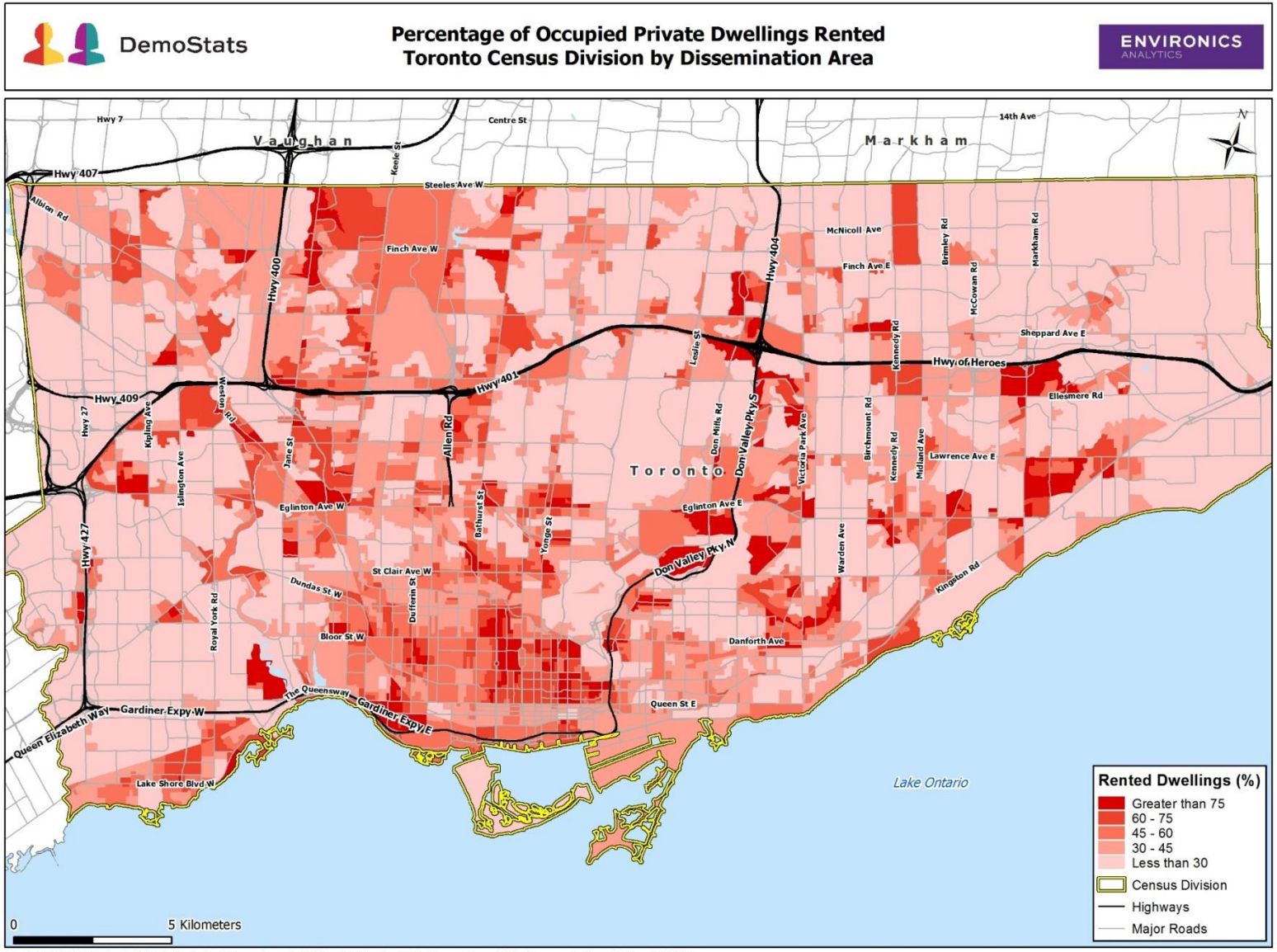
- Then I show some derived maps of interesting behaviours and values



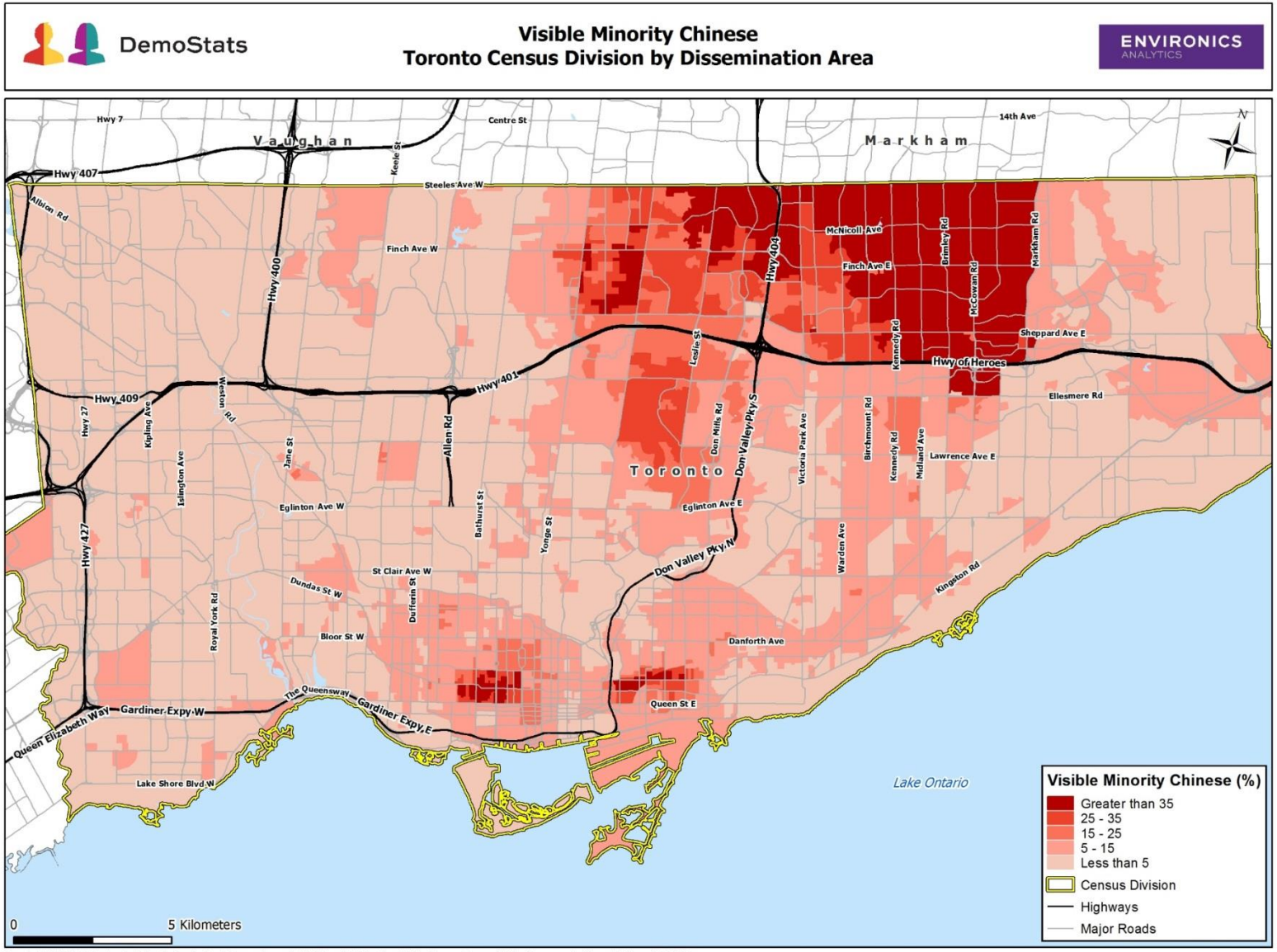
% age
65 plus



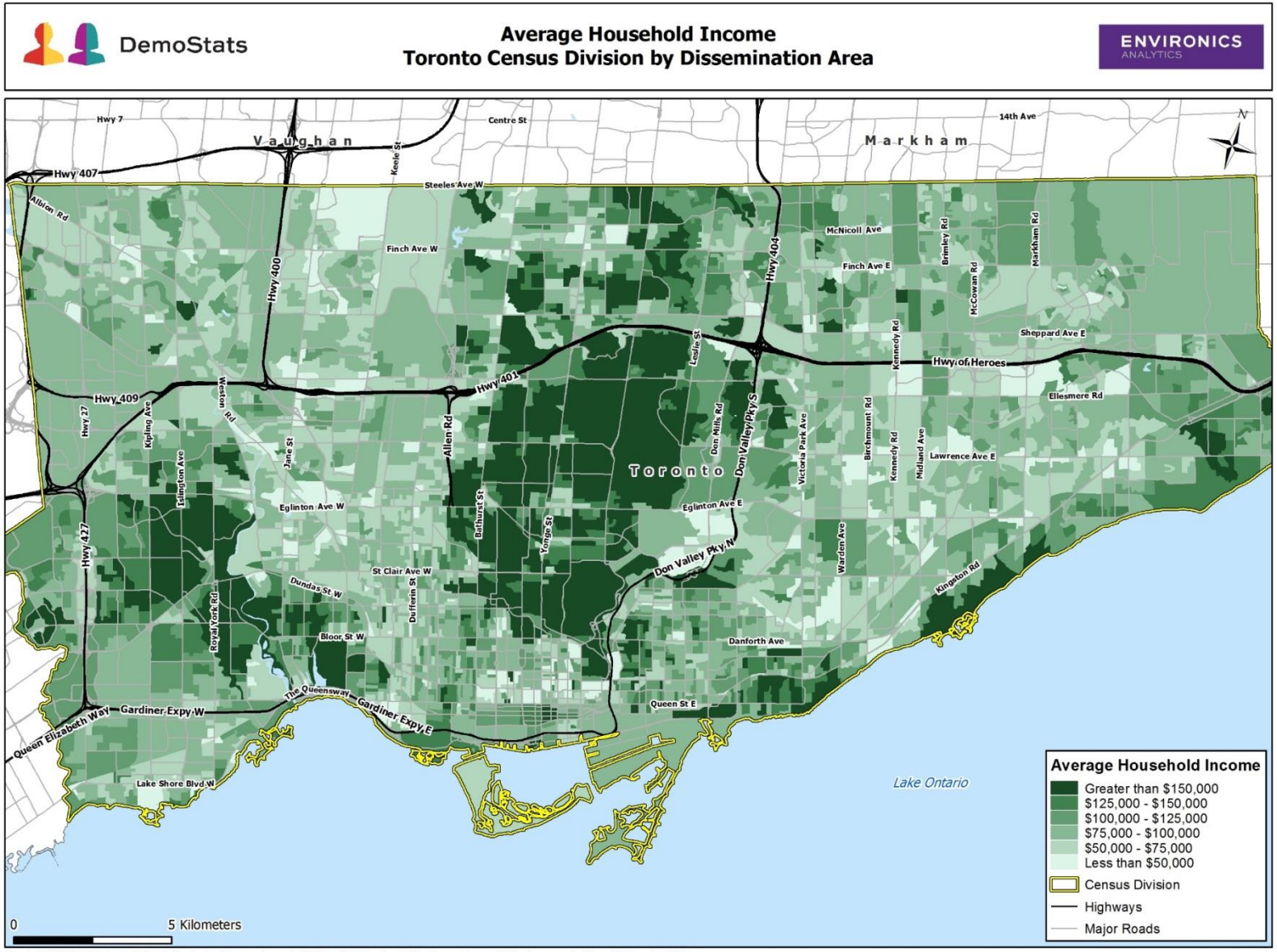
% families with children



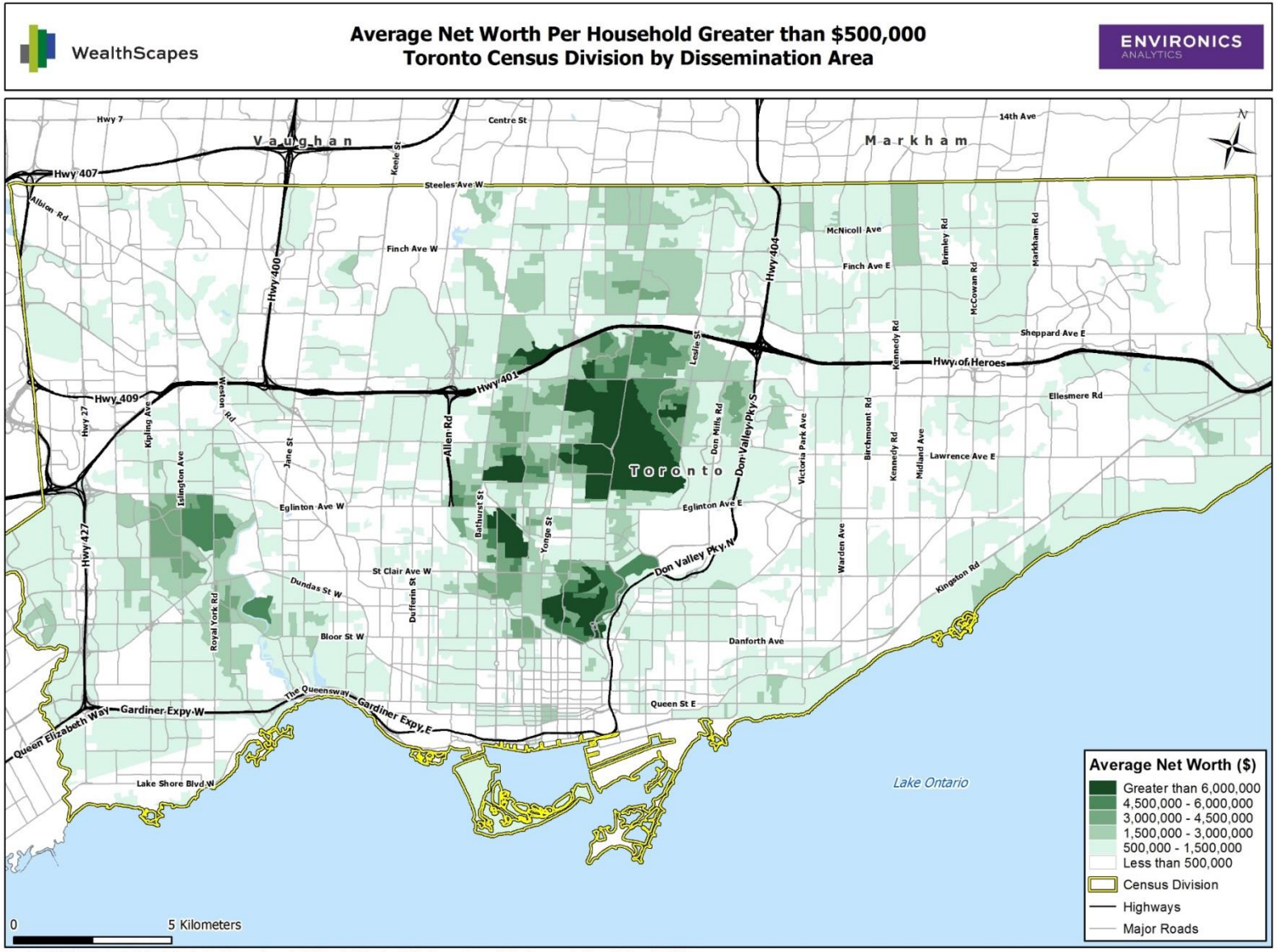
% occupied dwellings that are rented



% population that is visible minority Chinese

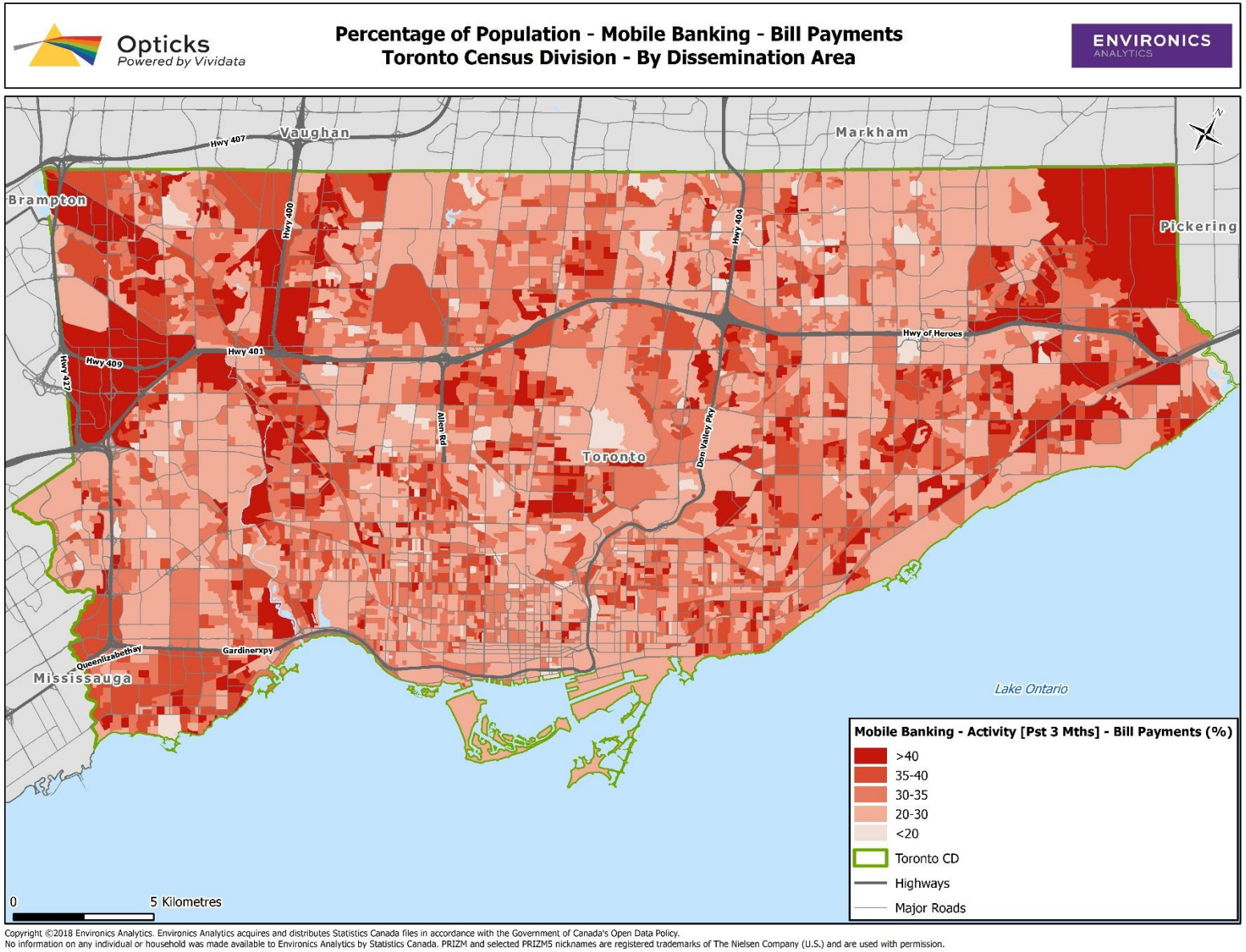


Average household income

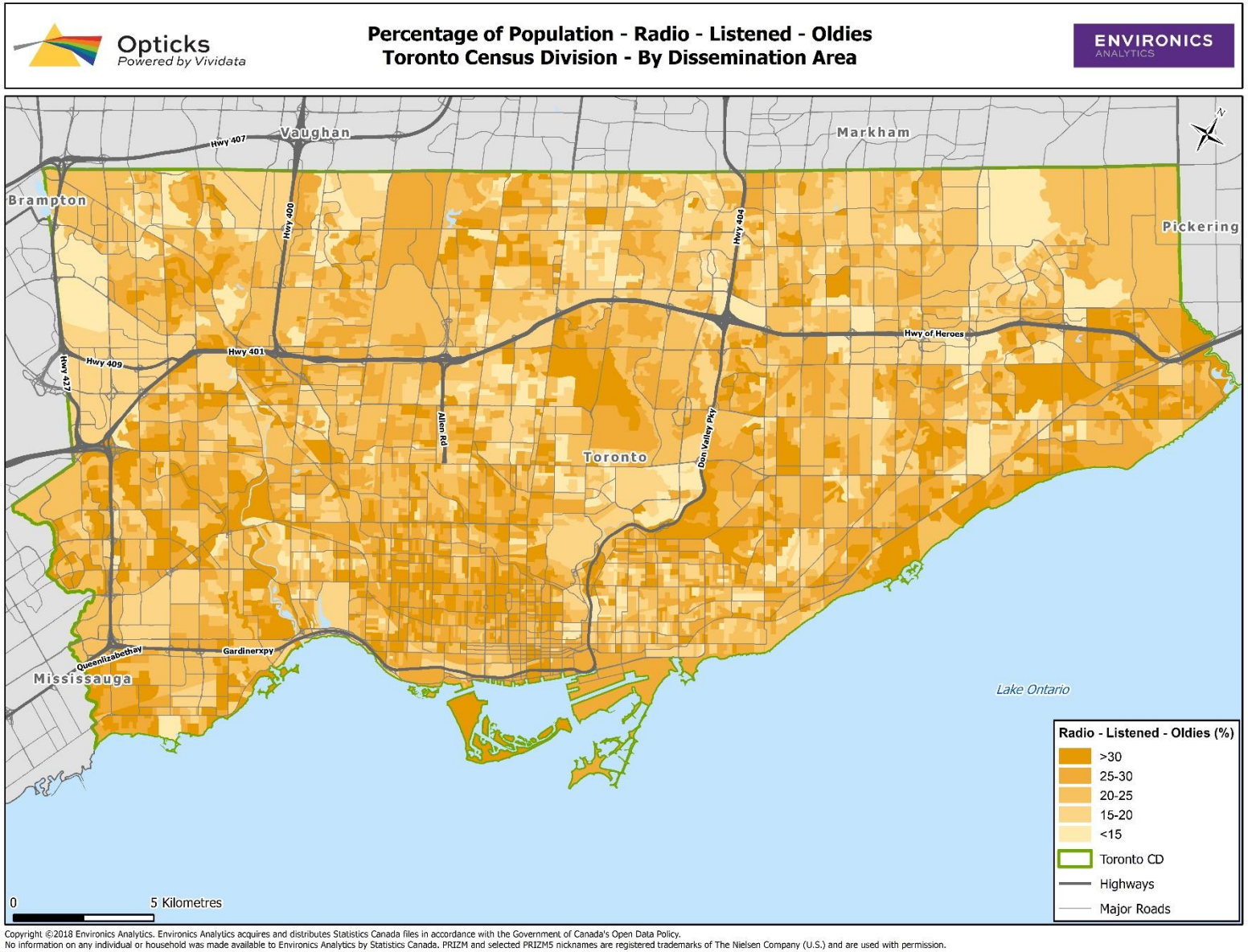


Net worth is created by EAG
- not census-based

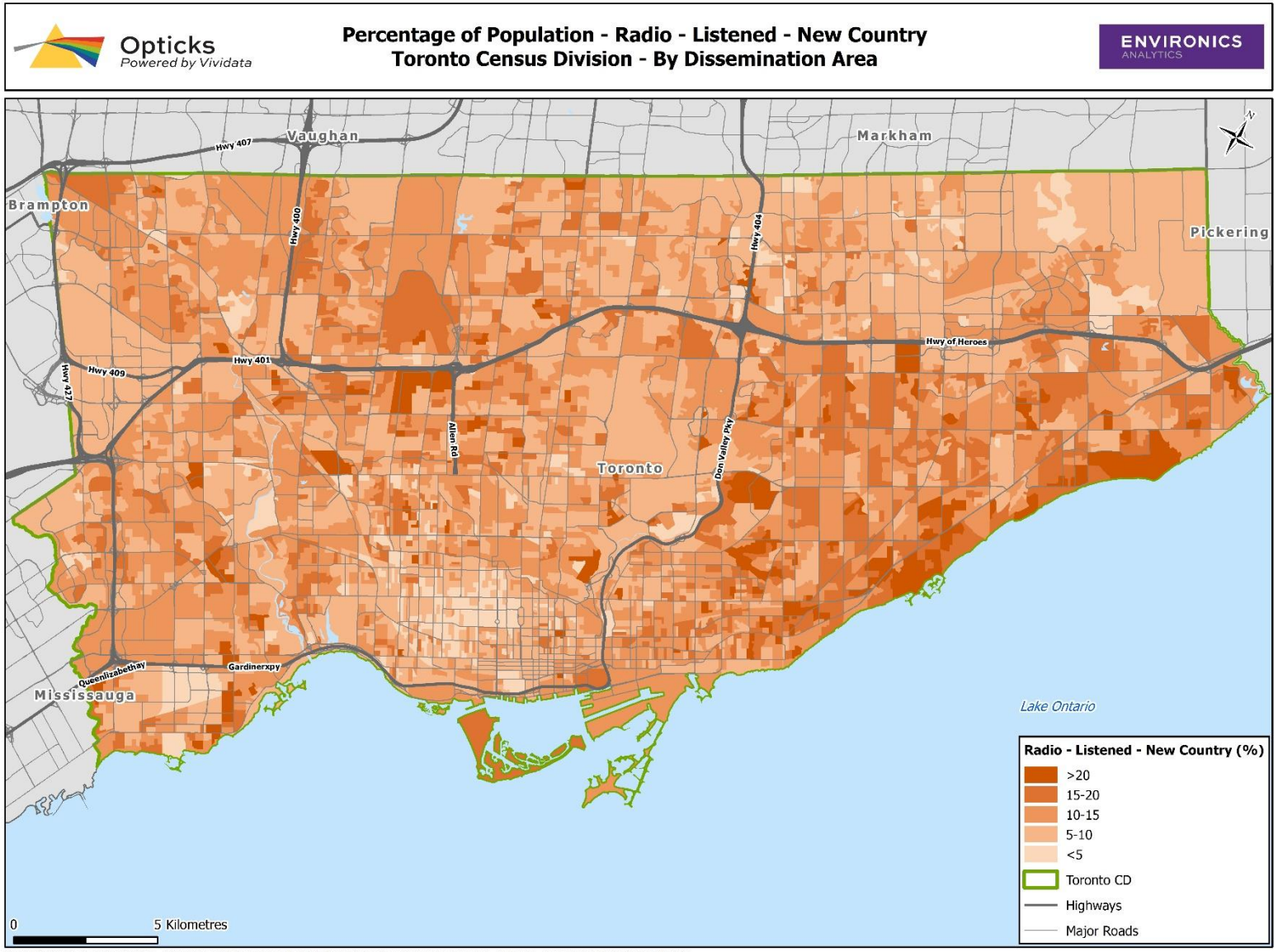
NOW BEHAVIOUR…



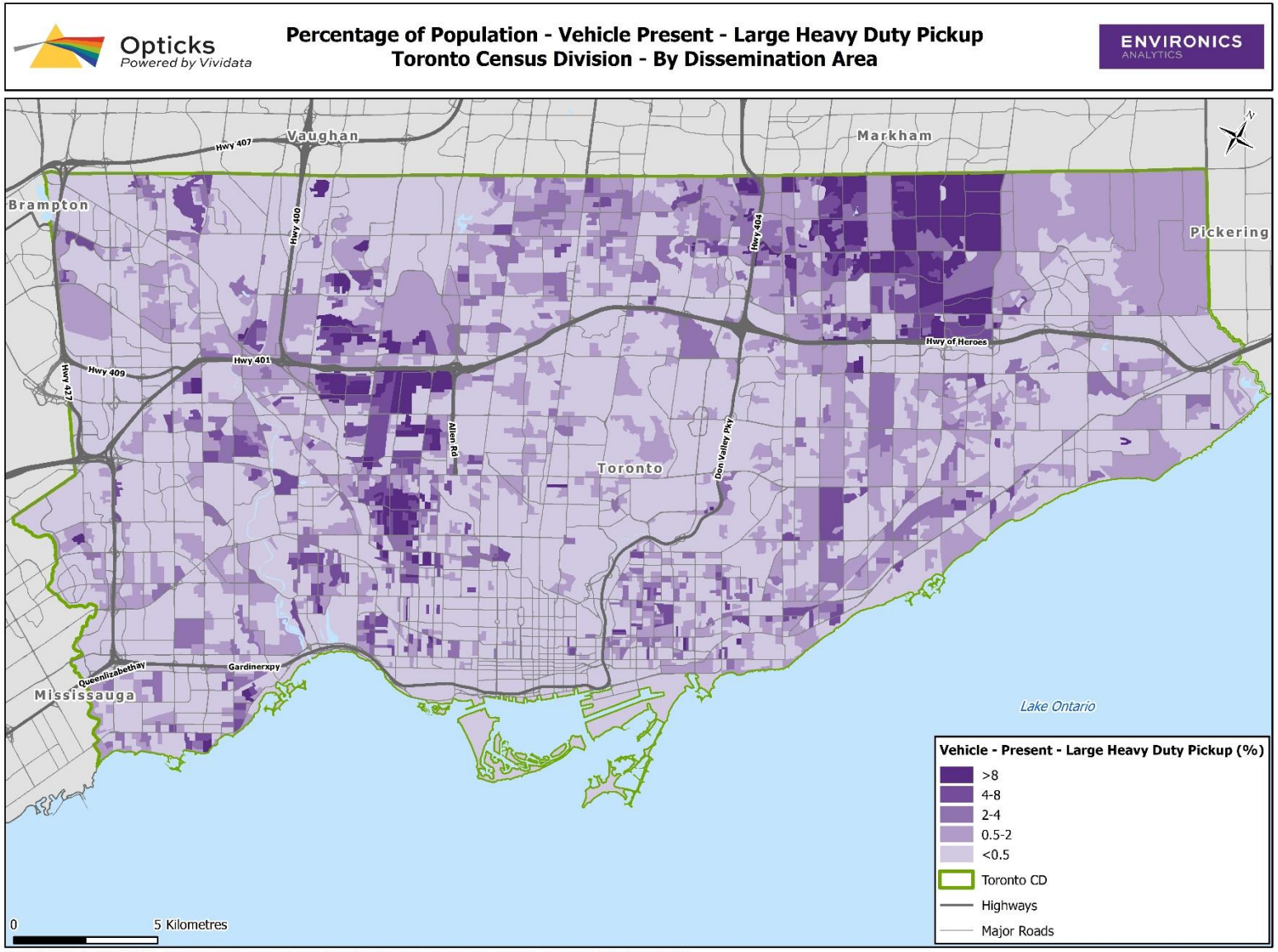
% that used mobile banking (past 3 months)



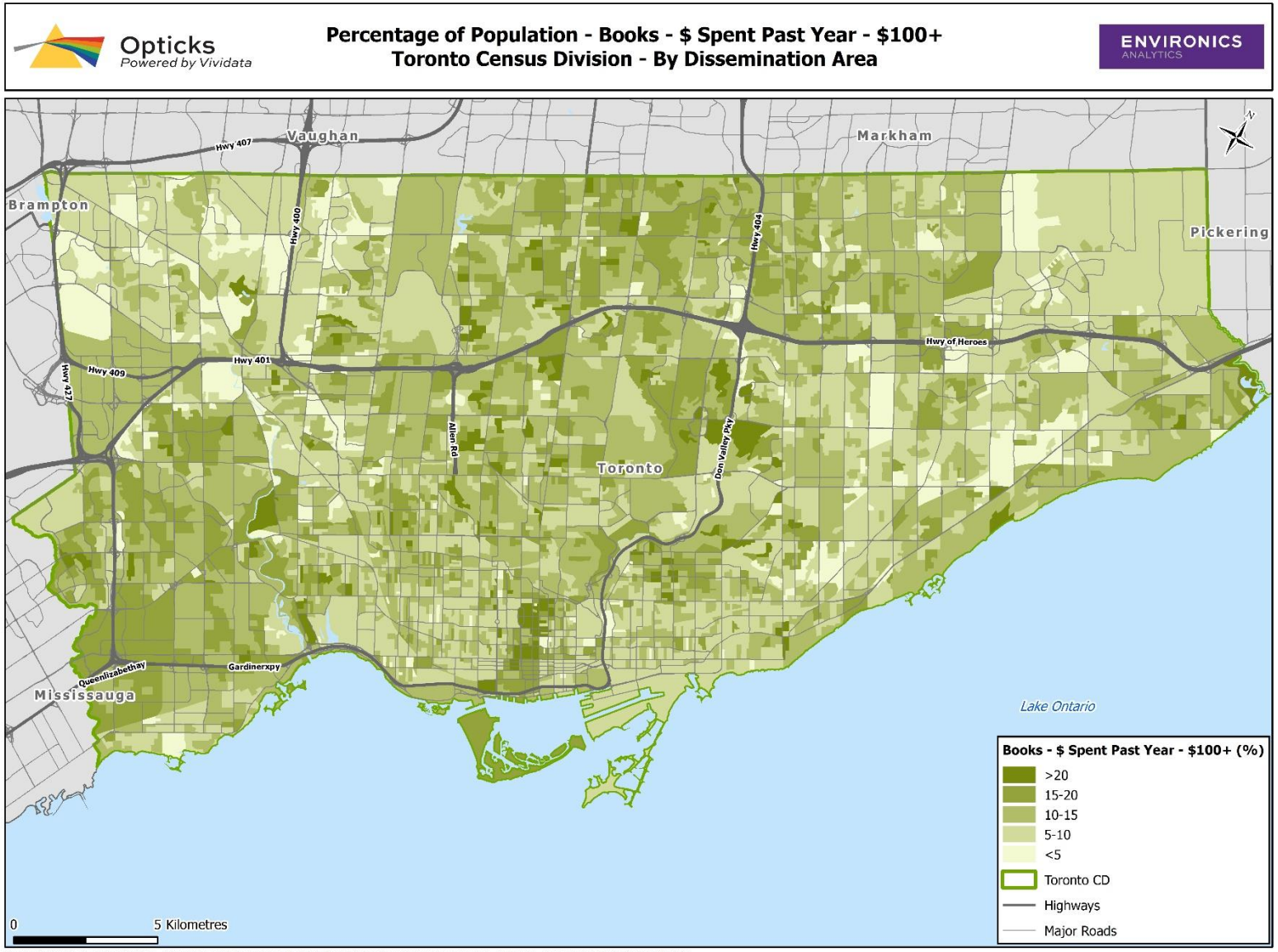
% that listen to oldies radio



% that listen to new country radio



% that own a large heavy pick-up truck

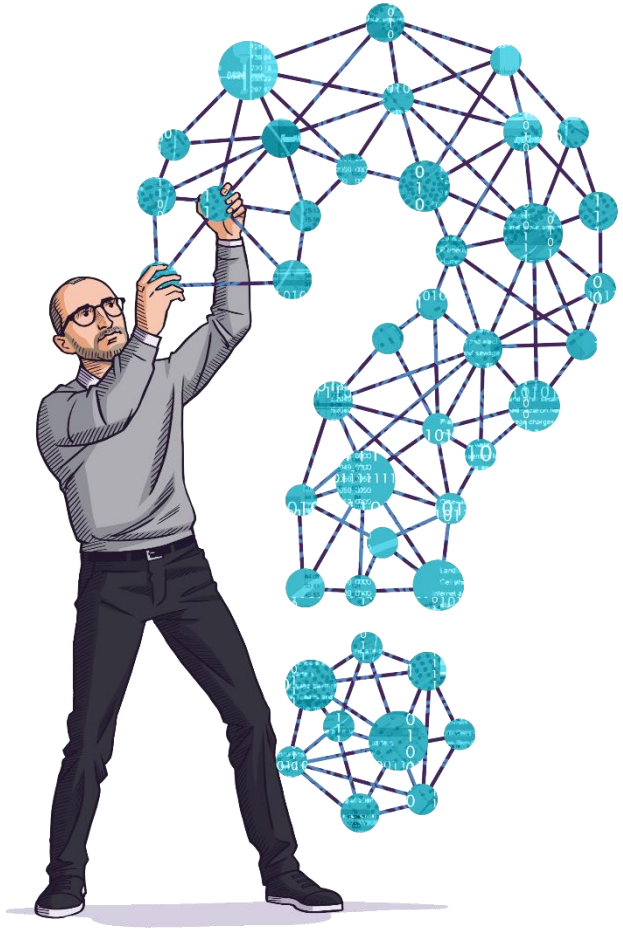


% that spent over $100 on books in the last year

CONCLUSIONS

- Lots of good data in almost every area (customer data, big data, large surveys)
- These data are tied to persons one at a time and goal of integrated view of the customer is not possible
- Aggregation to small area geography allows all datasets with a spatial reference to be tied together to analyse and derive conclusions
- The geodemographic approach
- Socioeconomics and demographics at small area level can be clustered well to make good looking meaningful segments
- Segments simplify profiling of customers and also targeting of new customers

QUESTIONS?



THANK YOU

Tony Lea

Chief Methodologist and Senior Vice President

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