

Housing Affordability in Vancouver: Visualization and Analysis

An interactive Shiny app that displays Vancouver's residential real estate market from 2006 to 2016

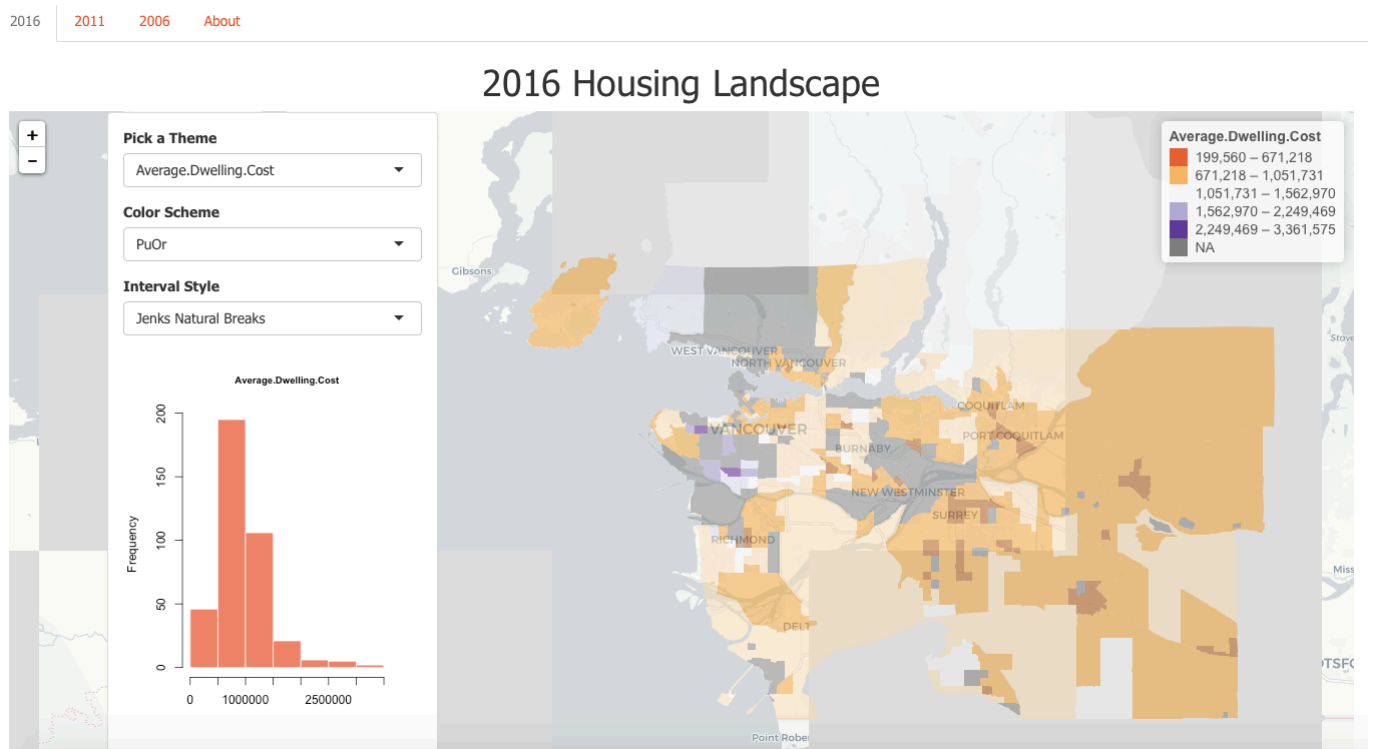


Figure 1: 2016 Housing Landscape map displaying average dwelling cost per neighbourhood

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Summary

The Vancouver Housing Affordability tool aims to illustrate the city's residential landscape over the past 10 years using Canadian Census data. It provides two functions: displays housing trends from 2006 to 2016 and calculates how long it would take the average Vancouverite to save in order to pay for the minimum down payment in each neighbourhood (Census Tract), also referred as the housing affordability index. Depending on the user's variable choice, a choropleth map will be generated. The tool intends to improve both policymakers and potential homebuyers' understanding of Vancouver's housing market. It has been built in R studio and hosted on a shiny web app.

Introduction

Vancouver is grappling with a housing crisis. According to a recent study made by Point2Homes, a real estate firm, Vancouver ranks the most unaffordable city in North America – challenging cities like Manhattan and San Francisco (Tierney, 2017). The average detached house in Vancouver is \$1.831 million (Globe and Mail, 2017).

Exorbitant prices are forcing families to move to the outskirts, resulting in an urban sprawl as more citizens are moving to the periphery. Soaring house prices are impacting everyone, particularly the younger generation. According to the 2016 Canadian Census, one in three adults aged 20-34 years old live at home with their parents.

The housing problem can be attributed to several factors, including foreign investment (Gordon, 2016). Vancouver has experienced an influx of foreign money into residential properties, driving prices up.

In response to foreign ownership, citizens are forcing the government to intervene. In July 2016, the province implemented a foreign buyers tax of 15%. However, the policy did not deter foreign investors for long (McElroy, 2017).

Potential first time homebuyers are becoming increasingly skeptical of owning a home in their city. Due to the lack of accessible housing data, homebuyers are finding it difficult to identify areas they can afford based on their current financial situation. This application hopes to educate Vancouverites and policymakers on the current housing climate and spur discussion on improving local accessibility and affordability.

Input Data

The tool requires two different data sets for each year displayed: a census tract boundary shapefile and housing data (Statistics Canada). Census tracts are based on population, in Canada a census tract ranges from 2,500 to 8,000 (Statistics Canada, 2015). As the population grows, census tracts split into new ones. Table 1 illustrates the increase in census tracts over the past 10 years:

Year	Number of Census Tracts
2006	410
2011	457
2016	478

Table 1: Number of Census Tracts per Year

Consequently, each year's housing data must be projected on a new map because the boundaries differ over time.

The housing data revolves around three major themes: income, monthly rent and dwelling cost. Census questions are not consistent each year, however this paper has found the closest variables to portray the above themes. Table 2 displays variables used to measure income, rent, and dwelling cost per census year.

Year	Income	Rent	Dwelling Cost
2006	Total income in 2005 of population 15 years and over - 20% sample data / Average income \$	Tenant-occupied private non-farm, non-reserve dwellings / Average gross rent \$	Owner-occupied private non-farm, non-reserve dwellings / Average value of dwelling \$
2011	Income of individuals in 2010 (part 1) - Both sexes / Total income in 2010 of population aged 15 years and over; Both sexes / Average income \$; Both sexes	Shelter costs / Number of tenant households in non-farm, non-reserve private dwellings / Average monthly shelter costs for rented dwellings (\$)	Shelter costs / Number of owner households in non-farm, non-reserve private dwellings / Average value of dwellings (\$)
2016	Total Sex / Total - Income statistics in 2015 for private households by household size - 100% data / Median total income of households in 2015 (\$)	Total Sex / Total - Tenant households in non-farm, non-reserve private dwellings - 25% sample data / Average monthly shelter costs for rented dwellings (\$)	Housing - Total Sex / Total - Owner households in non-farm, non-reserve private dwellings - 25% sample data / Average value of dwellings (\$)

Table 2: Breakdown of Variables per Theme and Year

Housing Affordability Index

(Years Needed to Save to Pay for Down Payment)

As mentioned before, Vancouver is one of the most expensive cities to live in North America. This index predicts how long it would take the average Vancouverite to save in order to pay for the minimum down payment in each census tract using the below equation:

$$\frac{(\text{Mean Dwelling Cost} \times \text{Down Payment})}{\text{Mean Income} \times 0.15}$$

0.15 = Estimated savings percentage of income each year (Abodo, 2017)

Mean income in Vancouver= \$78,522 (2016), \$41,006 (2011), \$36,164 (2006)

Minimum required down payments vary depending on house value. The Canadian government outlined the minimum down payment for each housing price tier (Financial Consumer Agency of Canada, 2017):

- 5% for dwellings below \$500,000
- For dwellings above \$500,000 and below \$1,000,000, a homebuyer must pay 5% on the first \$500,000 and 10% on the rest
- 20% on \$1,000,000 and plus

2016 2011 2006 About

2016 Housing Landscape

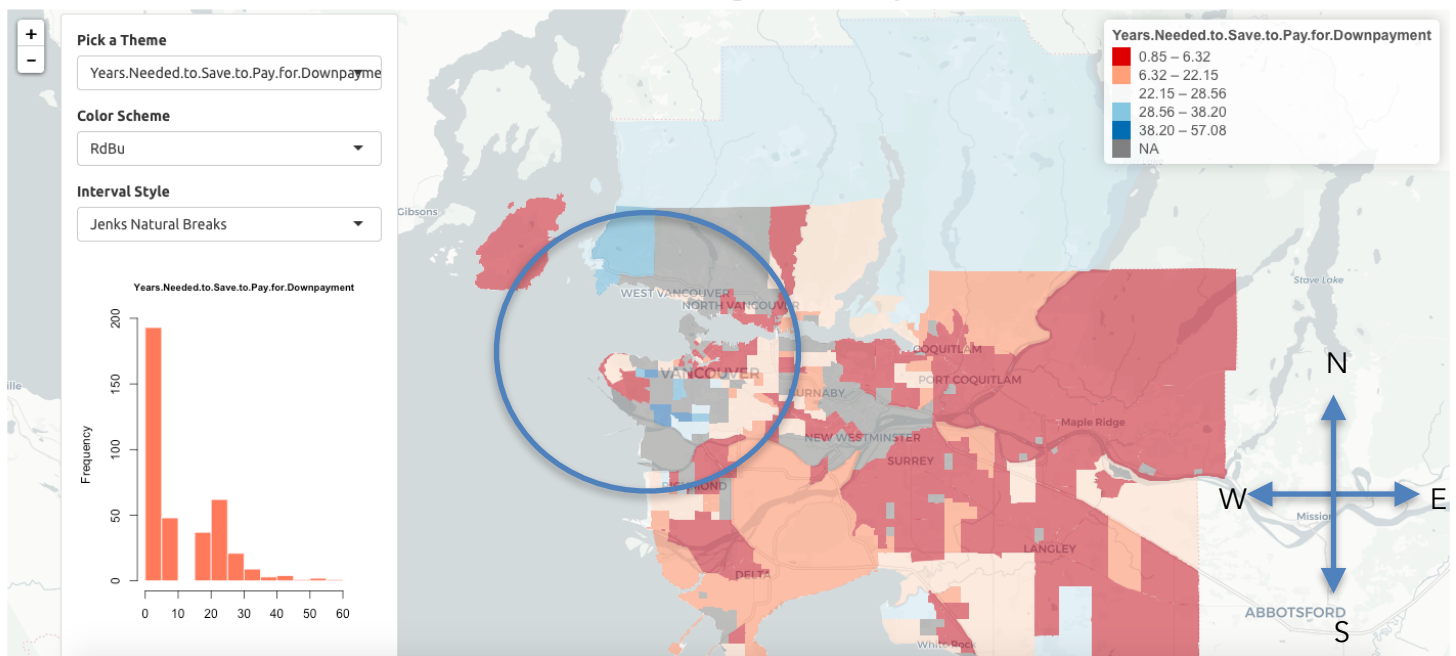


Figure 2: Housing Affordability Index - Years Needed to Save to Pay for Down Payment 2016

In Figure 2, South Vancouver to West Vancouver (within the blue bubble) further demonstrates the obscene real estate prices for local citizens. The average Vancouverite with an income of \$78,522, would take approximately 28 to 58 years to pay the minimum down payment in these areas, if they are saving from scratch.

Process

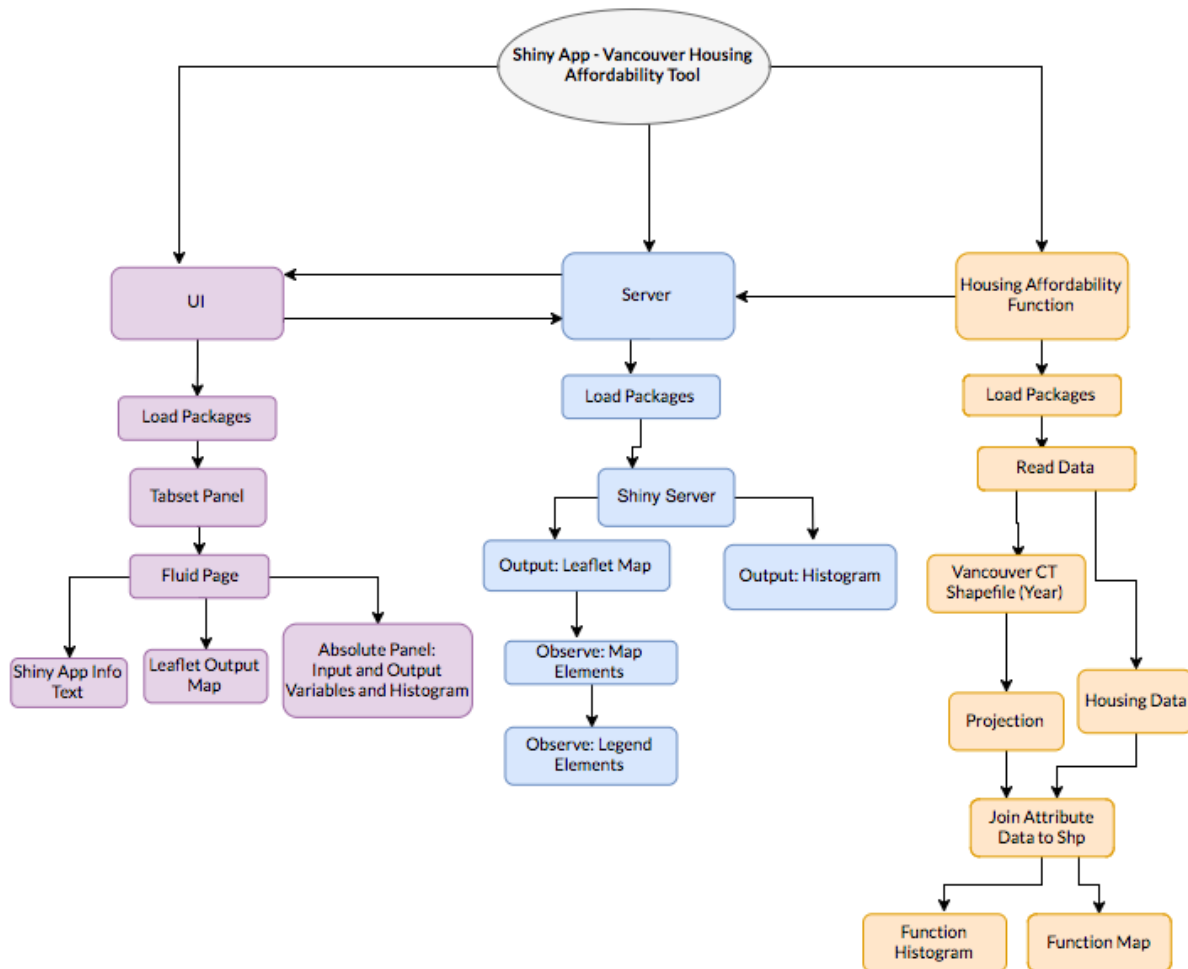


Figure 3: Flow of Housing Affordability Function

- 1) Inside the housing affordability function (realestateyvr.R), both the shapefile and housing data are loaded. The shapefile is projected onto the WGS84 coordinate system. After cleaning the data and taking out unnecessary rows and columns, it is merged with the Vancouver census tract shapefile to create the histogram and map function.
- 2) The UI has three panels to display each year's housing landscape map. It shows the user the outputted Leaflet map and histogram, depending on the user's variable choice. The styling of the app was based on a bootstrap template (Park), an open source design library.
- 3) The server is the backend application that hosts the Shiny app. It communicates with the UI to change the output map depending on the user's chosen variable and then sends the information to the UI to render the result.

Figure 3 is a breakdown of each function's impact on the tool and how it supports it.

All maps are based on a spatial visualization tool - "leaflet" in R Studio (Joe Cheng, 2017). R Studio was chosen since it provides a user-friendly interface to enable endusers a seamless interactive experience.

Operation

The tool enables the user to pick from the following variables to understand Vancouver's housing climate in each census year (refer to Figure 4):

- Average Monthly Rent
- Housing Affordability Index: Years Needed to Save to Pay for Down Payment
- Average Monthly Income
- Average Yearly Income
- Average Dwelling Cost
- Percentage of Income Spent on Rent

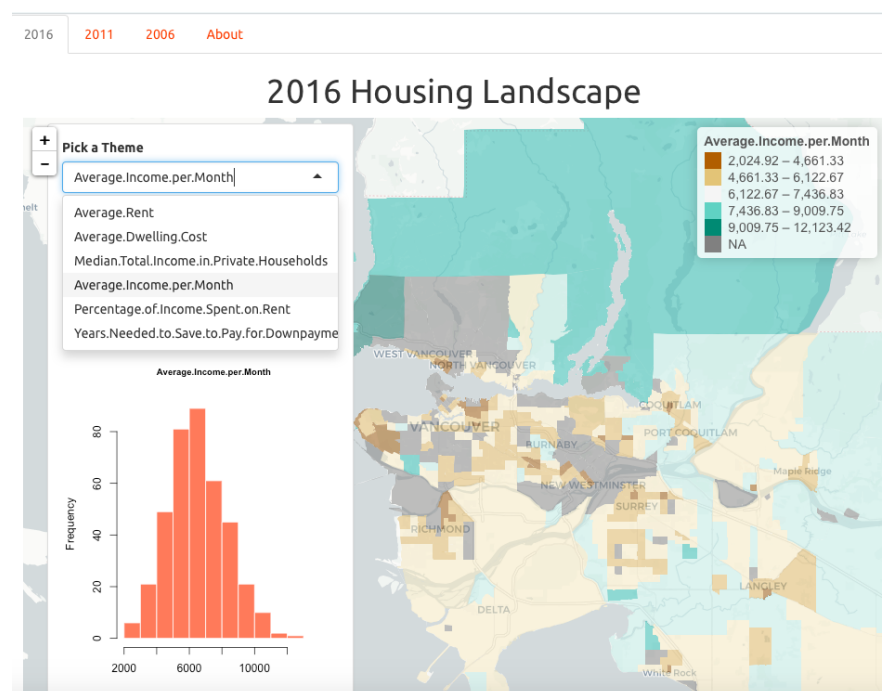


Figure 4: List of variables displayed in tool

Users are also able to choose a colour scheme and Interval style depending on their preference. After choosing a variable, a choropleth map is generated and histogram developed to show the variable's frequency.

Results

This tool can be used to simply generate choropleth maps to display housing trends in the past 10 years. It enables users to see patterns and identify areas that are affordable based on their price points.

As for housing trends, this analysis located affluent areas – characterized by dwelling cost – from South Vancouver to West Vancouver. This is consistent throughout 10 years as seen in Figure 5:

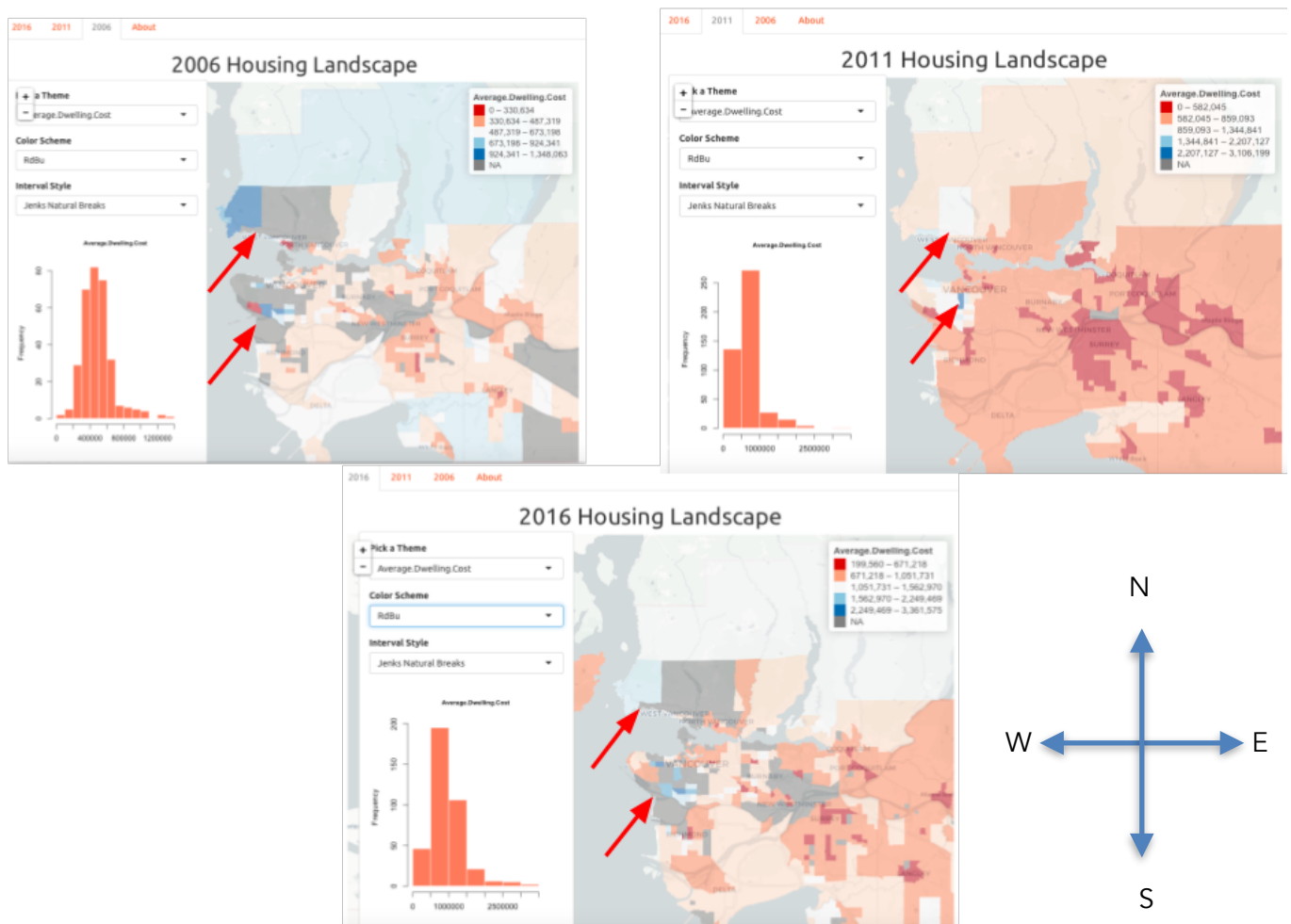


Figure 5: Average dwelling cost from 2006 to 2016

Blue shaded areas house the most expensive dwellings. South and West Vancouver are considered suburbs with few apartment buildings and many medium to large land plots. It is not surprising that they are deemed as one of the most expensive areas. They are also an attractive investment for foreign buyers looking to emigrate to Canada in the future. These

areas have some of the top performing schools in the province and are only 15 minutes away from downtown core.

Limitations and Future Improvements for Further Editions

This tool can successfully serve to understand the housing climate on a basic level. Many Vancouverites currently rely on anecdotal information, which is where this tool can play an important role in bridging the knowledge gap to explain the severity of situation. The Shiny web app can be accessed to all using this [link](#).

The major limitations lie in available data. The variables change every census year and therefore we cannot perform the most optimal comparison among the selected years. Furthermore, the majority of 2016 data is based on 25% sample data, and does not depict the whole picture. There are also several missing data points from neighbourhoods (listed as NA). Another limitation are the changing census tract boundaries to accommodate population growth. Three different shapefiles had to be displayed separately. Lastly, the housing affordability index acts as a simple guideline to display the worsening housing conditions for local citizens. It assumes the following: prices of houses are stagnant, users' will typically save 15% of their income, income does not change and, the index does not account for inflation.

Potential additions, would be to ask users to input their own information. The tool would then tailor the output to meet their parameters. Lastly, it would be interesting to map out the percentage of foreign ownership in each area to further demonstrate their impact on the real estate market.

References

McElroy, J., 2017. 5 charts showing Metro Vancouver's affordability has become worse despite the foreign buyers tax. CBCnews. Available at: <http://www.cbc.ca/news/canada/british-columbia/foreign-buyers-tax-affordability-charts-1.4392059> [Accessed January 4, 2018].

Anon, 2015. Census tract (CT). Census Dictionary. Available at: <http://www12.statcan.gc.ca/census-recensement/2011/ref/dict/geo013-eng.cfm> [Accessed January 4, 2018].

Canada, G.of C.S., 2017. Boundary files. Government of Canada, Statistics Canada. Available at: <http://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-eng.cfm> [Accessed January 3, 2018].

Statistics Canada: 2006 Census

Statistics Canada: 2011 NHS (National Household Survey)

Statistics Canada: 2016 Census

Anon, 2017. As Metro Vancouver's affordability gap widens, a search for answers. The Globe and Mail. Available at: <https://www.theglobeandmail.com/real-estate/vancouver/as-metro-vancouvers-affordability-gap-widens-a-search-for-answers/article35267249/> [Accessed January 3, 2018].

Gordon, J. 2016, Vancouver's Housing Affordability Crisis: Causes, Consequences and Solutions.

Park, T., Flatly. Bootswatch: Flatly. Available at: <https://bootswatch.com/3/flatly/> [Accessed January 3, 2018].

Tierney, A., 2017. Vancouver Ranked Most Unaffordable Housing Market in North America. Vice. Available at: https://www.vice.com/en_ca/article/j5jp3y/vancouver-ranked-most-unaffordable-housing-market-in-north-america [Accessed January 3, 2018].

Anon, 2017. [DATA] Millennial Homebuyers: Where Are Young People Buying the Most Homes? ABODO Apartments. Available at: <https://www.abodo.com/blog/millennial-homebuyers/> [Accessed January 3, 2018].

Canada, F.C.A., 2017. How much you need for a down payment. Canada.ca. Available at: <https://www.canada.ca/en/financial-consumer-agency/services/mortgages/down-payment.html> [Accessed January 4, 2018].

Anon, 2017. This article in the Census in Brief series paints a demographic picture of young adults living with their parents in 2016. It describes recent trends and differences between rural regions and large urban centres. Census in Brief: Young adults living with their parents

in Canada in 2016. Available at: <http://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016008/98-200-x2016008-eng.cfm> [Accessed January 4, 2018].

User Documentation

#Step 1: Data Prep

The tool reads the shapefile of Canadian Census Tracts and captures only Vancouver's region. It then projects the shapefile onto the Canadian coordinate system using `rgdal` and `sp` packages in R. However in this version, the tool projects it onto WGS84.

Attribute Data:

The housing data is in a csv format and is read using the `read.table` function. The data is converted into numerals in order to display onto the map. Once the data has been cleaned, the tool matches the attribute data to shapefile using the Census Tract codes.

#Step 2: Shiny App

The UI is created to display the layout of the app. It separates the tabs into years and allows the user to choose a colour scheme, theme/variable, and interval. After choosing the variable, the app will render a map and histogram showing frequency of variable. The design of the app is based on bootstrap, an open source design library.

The server supports the backend of the app, passing information to the UI based on the user's inputs.

User Guide

All housing data and shapefiles can be found in the 'data' folder. Since they are located locally, it is recommended that the folder is hosted directly in desktop. Having saved the folder on desktop, the user can open app.R to run the shiny app.

To see the housing affordability function, click on realestateyvr.R (run this file before app.R). All data and files are pulled from here.

Running Shiny app:

- 1) Run and load packages
 - a) Install packages that cannot be found
- 2) Click Run app button on top right corner ~ 1 minute
- 3) An external window will open, similar to Figure 6

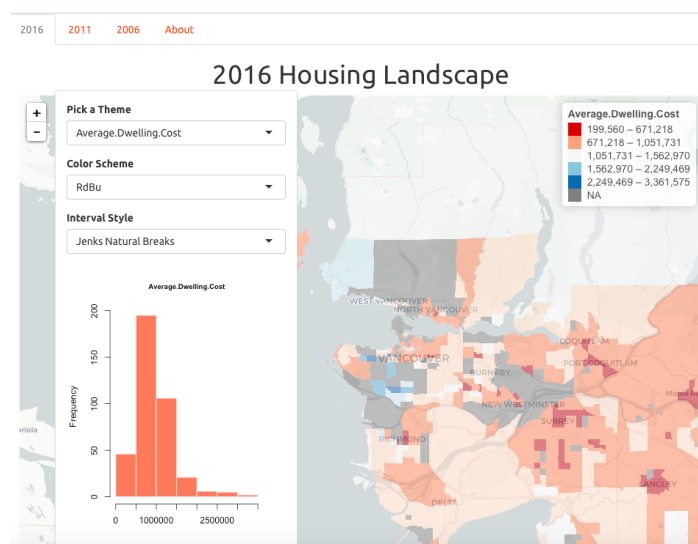


Figure 6: Shiny App

Output: Shiny visualization

For mapping purposes the tool's variables can be altered to examine housing trends in Vancouver over the past 10 years.

Alternatively, the Shiny web app version can be accessed using this [link](#).