CIRES Web Map Application Design Overview

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This report was produced as part of the Greenest City Scholars (GCS) Program, a partnership between the City of Vancouver and The University of British Columbia, in support of the Greenest City Action Plan.

This GCS project was conducted under the mentorship of City staff. The opinions and recommendations in this report, and any errors, are those of the author, and do not necessarily reflect the views of the City of Vancouver or The University of British Columbia.

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Acknowledgements

I would like to express my gratitude to the Social Policy and Projects Division and the Community Impact Real Estate Society (CIRES) for giving me this opportunity to take part in such a memorable journey. Thank you to my mentor, Wes Regan, Social Planner in the Arts, Culture and Community Services department for his guidance and advice throughout the program. I would also like to thank the GIS & CADD Services department for their input and technical support. Finally yet importantly, this study would not have been possible without the data that was shared by the City of Vancouver Open Data Catalogue.

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Background

The City of Vancouver has been working on providing an inclusive, safe, healthy and livable neighbourhood in the Downtown Eastside (DTES) for many years. There are currently a number of initiatives, such as the Community Economic Development Strategy that provides policies and strategies to improve income and the livelihood of low-income residents in the DTES. The strategy includes social purpose real estate collaboration, increasing incomes and reducing poverty through inclusive and flexible job creation and low-income self-employment initiatives etc. These strategies align with two of the Healthy City Strategy goals: (1) making ends meet and working well, (2) being and feeling safe and included.

The Community Impact Real Estate Society (CIRES) is one of several initiatives underway that are helping to achieve goals in the DTES CED Strategy, Healthy City Strategy, and DTES Plan. CIRES was created jointly by BC Housing, the City of Vancouver, and the Vancity Community Foundation to encourage social purpose real estate innovations in the commercial real estate sector. CIRES role is to manage cross-subsidized retail spaces in the DTES with a focus on the V6A postal code (see Figure 1 for the V6A postal code extend). It aims to support social enterprises, non-profit organizations and businesses that work on reversing the impact of social isolation, limited employment opportunities, and unaffordable retail and service options for low-income residents in the DTES. Revenues generated from properties are used to subsidize spaces for socially inclusive businesses. Through the management of these commercial spaces, CIRES contributes to the development of affordable socially inclusive businesses and economic opportunities for low-income workers. This also works in conjunction with the city's 2025 goal of reducing poverty by 75%, increasing median income by at least 3% per year, and increasing residents' sense of belonging.

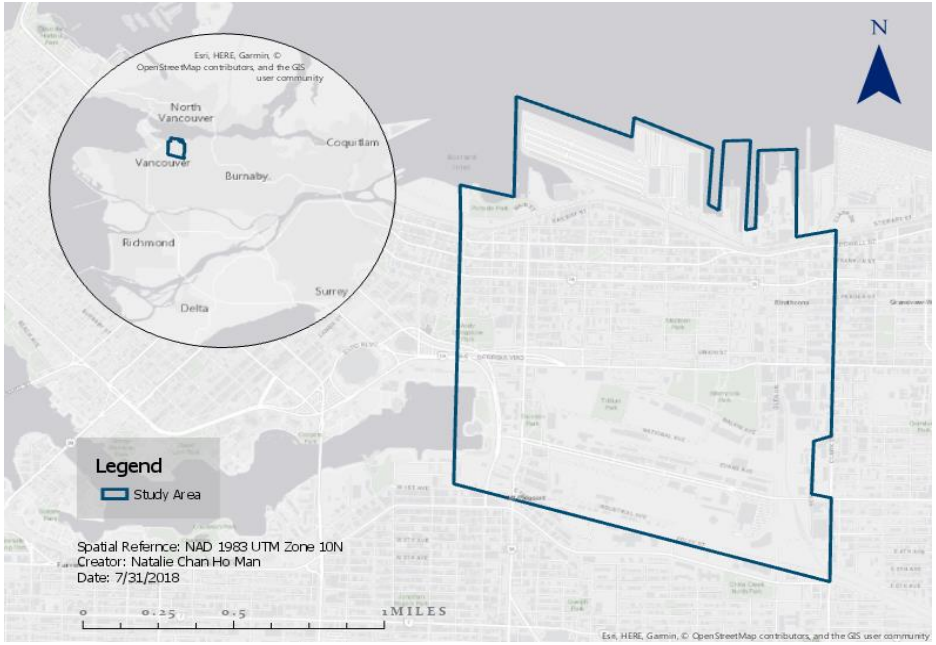

Figure 1. V6A postal code extend, study area of this project.

The purpose of this project is to assist CIRES in developing an efficient and updateable geospatial dataset that establishes a baseline of space, uses, and metrics for its retail portfolio. This database is intended to be regularly updated and to interface with a GIS platform for data visualization. The GIS platform is based on the CIRES Web Map application. It is an interactive online interface that enables fast and easy analysis of data to support data-driven decisions. The application's ultimate goal is to allow CIRES to track and communicate the impact of its portfolio over time using a spatial representation of data.

This report provides an overview of how the CIRES Web Map application was created. It also includes a summary of the data collection process, how the data is analyzed, the web application widget choices as well as some of the challenges and decision-making points throughout the project.

The CIRES Web Map Application

What is the CIRES Web Map Application?

The CIRES Web Map Application supports utilizing spatial data in making data-driven decision. The use of spatial data can provide visualization of patterns that are otherwise unlikely to be spotted in raw data. Data visualization techniques such as heat maps, where the concentrations of particular indicators are visually represented through colours and gradients, enable users to recognize a spatial pattern, identify important locations and perform statistical analysis.

The use of Geographic Information System (GIS) software provides users with a number of tools to analyze data. It is particularly useful for real estate practices as property is geospatial in nature and the significance of location is crucial (Donlon 2007). This online web application, in particular, provides a more interactive and user-friendly interface that allows users with little experience in GIS software to navigate and analyze data. This project demonstrates the use of GIS technology in the real estate industry and its ability to allow CIRES to track and monitor changes of the DTES over the years. The most crucial outcome of this project is the foundation on which additional improvements and datasets can be added in the future, as well as some important suggestions for future challenges.

Donlon, K. H. 2007. Using GIS to improve the services of a real estate company. Resources Analysis , Volume 10. Saint Mary's University of Minnesota Central Services Press. Winona, MN.

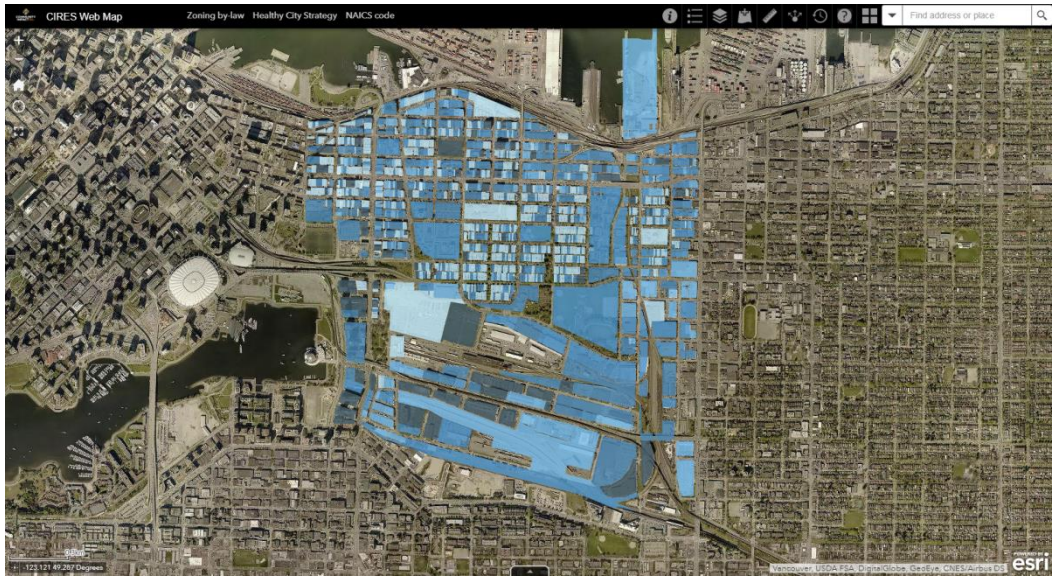

Figure 2. Example of the interface of the CIRES Web Map Application.

Data acquisition and processing

This web application makes uses of two GIS programs: ArcGIS Pro version 2.1.2 from the Environmental System Research Institute (ESRI) and Quantum GIS version 3.2.0. The majority of data collected for this study were retrieved from the Open Data Catalogue from the City of Vancouver. The Open Data Catalogue provides free spatial data online under the Open Government Licence – Vancouver. Listed below are all the layers included in the web application with data source, processing details and an example of the display layout in the web application. There are a total of 15 layers available on the app: (1) Tie Lines, (2) BIA Area, (3) Year Built, (4) Zoning District, (5) Employment Number, (6) Land Assessment Value – 2016, (7) Land Assessment Value – 2017, (8) Tax Revenue – 2016, (9) Tax Revenue – 2017, (10) Business Licence -2017, (11) Business Licence 2018, (12) Lease Rate – Heat Map, (13) Lease Rate – Points, (14) Building Footprints, (15) Study Area.

These 16 different layers will now be explored further along with specific technical considerations faced and considered in the project.

Tie Lines

The tie lines layer is a line layer that displays where two or more parcels are being treated by the BC Assessment Authority as one large parcel. The parcels indicated as one parcel with tie lines will have the same owner and share one assessment roll number. Crucial when navigating the tax revenue layers and land assessment value layers as only one small parcel among the parcels that were register as one big parcel displays data.

Data Source:

Shapefile collected from the City of Vancouver's Open Data Catalogue property information data package.

Data Processing:

"Clip" from ArcGIS Pro was used to display tie lines for the V6A postal code area.

Display method and Rationale:

The tie lines layer was displayed as solid lines in the map. Pop-up were disabled as only the location of tie lines is important for this map. The tie line layer was chosen to be displayed as the top-most layer so it can also act as a reference when navigating any other layers.

Figure 3. Example of the display of tie lines on CIRES Web Map Application.

CIRES Address

The CIRES Address is a point layer that consist of the location of CIRES's commercial portfolio. This layer enables users to reference CIRES's commercial spaces' location when analyzing other layers.

Data Source:

Excel file of CIRES's address was provided by CIRES.

Data Processing:

"Create Feature Class" in ArcGIS Pro was used to create a blank point feature class. "Create Feature" was then used to create individual points and attribute data for CIRES's address.

Display method and Rationale:

The CIRES address layer was displayed as a point layer to clearly show the location of each point. Clustering was not used in this layer as this layer does not contain enough data to aggregate points into clusters. Pop-up of each points shows additional information of each location such as: building name, street name, and postal code.

Figure 4. Example of the display of CIRES address on CIRES Web Map Application.

Business Improvement Area (BIA area)

Business improvement area is a line layer that includes boundary areas for the City's BIA. BIAs are specially funded business districts owned by non-profit association of business tenants and property owners who join together in order to promote commercial viability of their business district. This layer is important for CIRES as different BIA have different neighbourhood images, events and programs, and financial assistance.

Data acquisition:

Information collected from the city of Vancouver's Open Data Catalogue business improvement areas (BIA).

Data processing:

"Clip" tool from ArcGIS Pro was used to extract BIA area for the study area.

Display method and Rationale:

The business improvement area layer was displayed in line polygons using different colours to represent different BIA area. Displaying the layer using lines instead of a solid polygon allows users to navigate other layers with the BIA area and base map still visible.

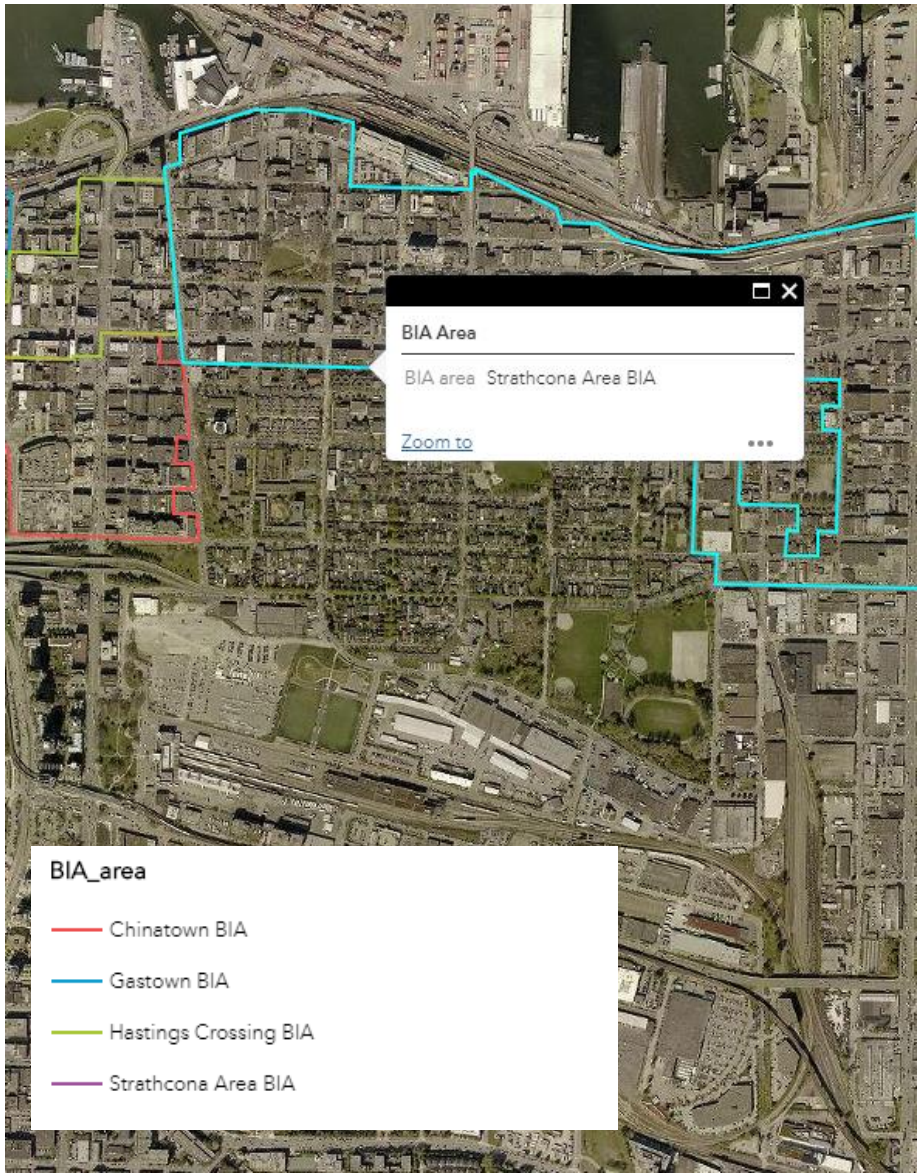

Figure 5. Example of the display of BIA Area on CIRES Web Map Application.

Year Built

The year built layer is a polygon layer that display building built year on each parcel in the V6A postal code area. This layer is important for CIRES as building built year is often related to the property's value and building condition.

Data source:

Data collected from the City of Vancouver's Open Data Catalogue property tax report data package.

Data processing:

The property tax report data was sorted and filtered in Excel to display data in the V6A postal code area. "Join field" in ArcGIS Pro was then used to join the Excel table to the parcel polygon.

Display method and Rationale:

The year built layer was displayed as a graduated colour polygon that represents the building built year. Built year data categorized into 5 subcategories: (1) 1900-1925, (2) 1925-1950, (3) 1950-1975, (4) 1975-2000, (5) 2000-2018. This display method allows users to clearly visualize a general comparison of buildings' built year in the V6A postal code.

Remarks:

There are 7% of null data in this layer as some data are not available on BC assessment database or the parcel is currently vacant. For more information on null data, go to challenges and recommendation.

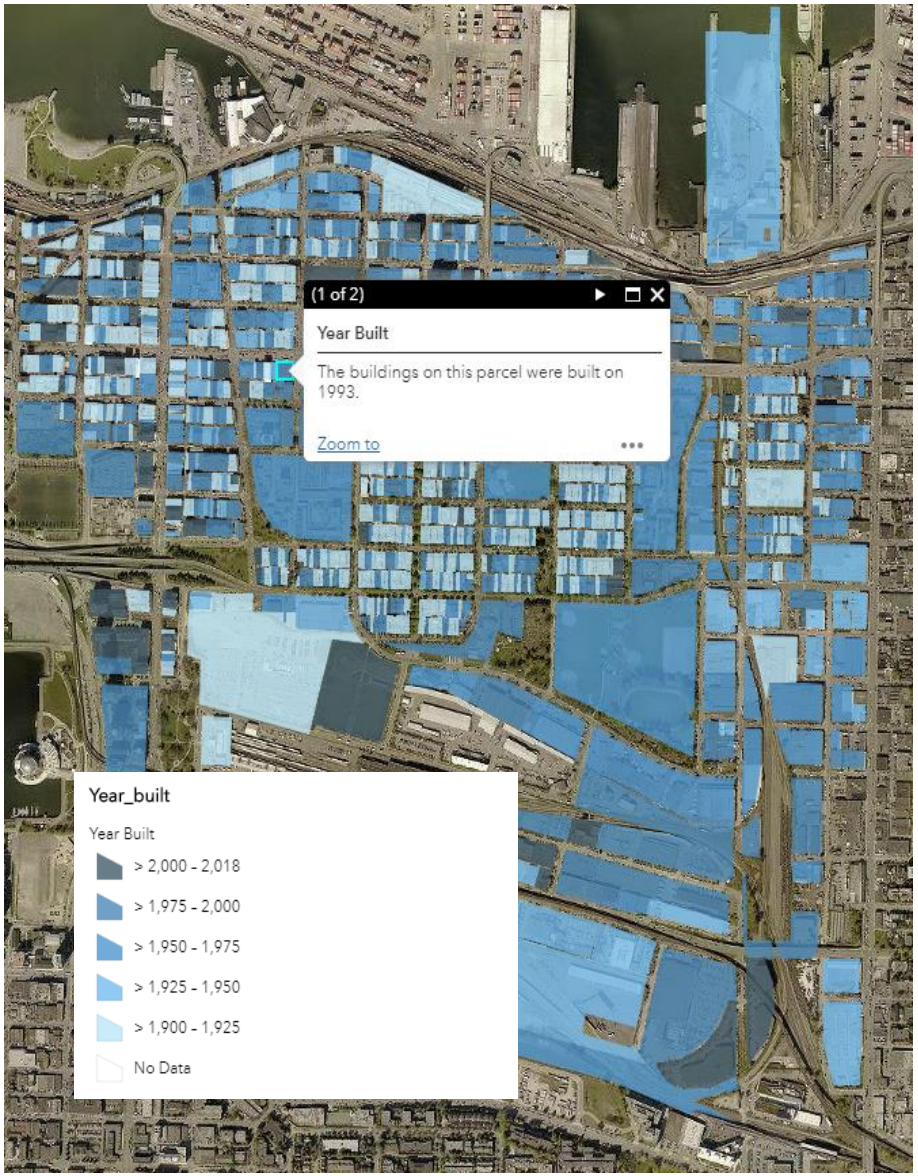

Figure 6. Example of the display of year built layer on CIRES Web Map Application.

Zoning District

The zoning district is a polygon layer containing the boundaries for zoning polygon throughout the V6A postal code. This layer is crucial for CIRES as each zoning district has a zoning and development bylaw that describes the details of development and land use in that district.

Data source:

Data collected from the City of Vancouver's Open Data Catalogue zoning districts and labels package.

Data processing:

"Clip" tool from ArcGIS Pro was used to extract districts for the study area and "Spatial Join" tool from ArcGIS Pro was used to join zoning data to parcel polygon for display.

Display method and Rationale:

The zoning district layer was displayed as a coloured polygon in different colours representing different zoning district. A coloured polygon display was chosen instead of a lined polygon in order to be more visually compatible with other layers.

Figure 7. Example of the display of zoning district on CIRES Web Map Application.

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Land Assessment Value – 2016 & 2017

The land assessment value layer is a layer that displays the land assessment value for each parcel. Land assessment value is the market value of the fee simple interest in land and improvements provided by BC Assessment for each tax assessment year.

Data Source:

Information collected from the City of Vancouver's Open Data Catalogue property tax report package.

Data processing:

Related addresses for each parcel was added into an Excel file. The property tax report data was sorted and filtered in Excel to display data in the V6A postal code area. "Join field" was used to join address file to the property tax report file. "Summary Statistics" was used to calculate the mean land assessment value for each parcel. "Join field" was used to join the newly created mean land assessment value to the parcel layer. "Make a relationship class" was then used to relate the property tax report file to the parcel using a one-to-many relationship. Two fields were then added to the attribute table, (1) Year_Start, and (2) Year_End. "Calculate Field" were then used to calculate the year start and year end for the related parcel. This parcel layer containing related tax report information was then published to ArcGIS online through ArcGIS Pro. Time was then enabled in ArcGIS online.

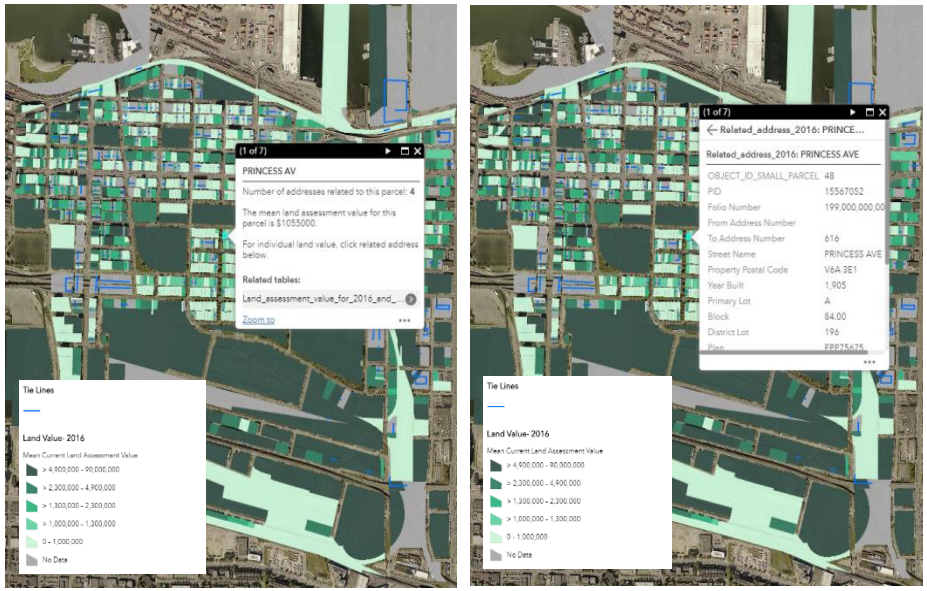

Figure 8. Example of the display of land assessment value . Left: Example of pop-up of initial layer. Right: Example of pop-up for related address of each parcel.

Display Method and Rationale:

The land assessment value layer was displayed as graduated colour polygons using the mean land assessment value. Land assessment value was shown from high to low using a dark to light colour scheme. This display method allows users to clearly visualize the general comparison of land assessment value for each parcel in the V6A postal code. Pop-up was enabled for users to search for individual tax levy data from the related address table

Remark:

Should be used in conjunction with the tie line layer. Only one parcel among those parcels that were treated by BC Assessment as one big parcel displays the mean tax revenue data. Turn on Tie lines layer for BC Assessment's parcel reference. Since the data of related address for each parcel is not available on the Open Data Catalogue. Much of the time was spent on gathering related address for this layer. For more comments of data availability, please go to Challenges.

Tax Revenue– 2016 & 2017

The tax revenue layer is a time enabled layer that display tax revenue information for each parcel in the V6A postal code area. Advance tax amount is also included.

Data Source:

Data collected from the City of Vancouver's Open Data Catalogue property tax report data package.

Data processing:

Related addresses for each parcel was added into an Excel file. The property tax report data was sorted and filtered in Excel to display data in the V6A postal code area. "Join field" was used to join address file to the property tax report file. "Summary Statistics" was used to calculate the mean tax levy for each parcel. "Join field" was used to join the newly created mean tax levy value to the parcel layer. "Make a relationship class" was then used to relate the property tax report file to the parcel using a one-to-many relationship. Two fields were then added to the attribute table, (1) Year_Start, and (2) Year_End. "Calculate Field" were then used to calculate the year start and year end for the related parcel. This parcel layer containing related tax report information was then published to ArcGIS online through ArcGIS Pro. Time were then enabled in ArcGIS online.

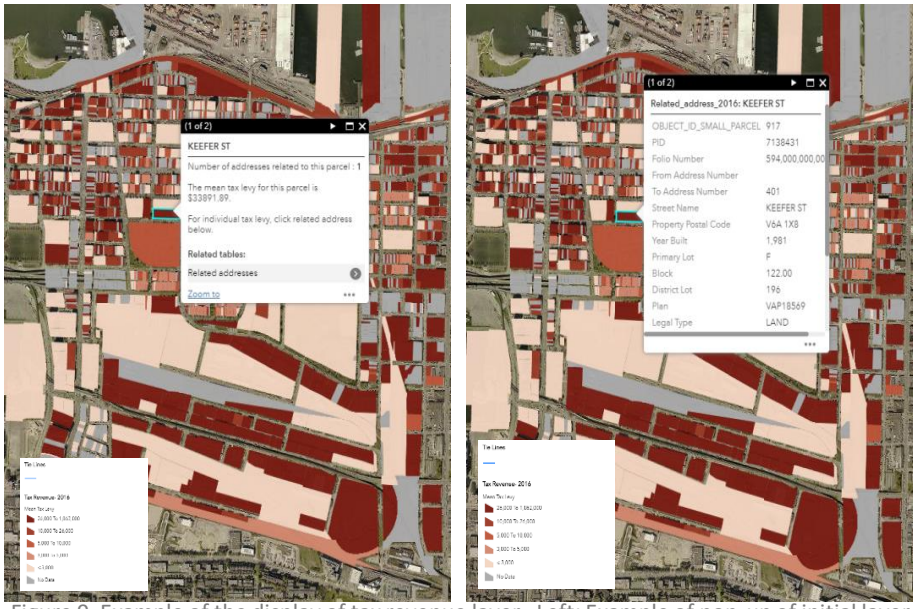

Figure 9. Example of the display of tax revenue layer . Left: Example of pop-up of initial layer. Right: Example of pop-up for related address of each parcel.

Display method and Rationale:

The tax revenue layer was displayed as graduated colour polygons using the mean tax levy value. Tax revenue was shown from high to low using a dark to light colour scheme. This display method allows users to clearly visualize the general comparison of tax revenue for each parcel in the V6A postal code. Pop-up was enabled for users to search for individual tax levy data from the related address table.

Remark:

Should be used in conjunction with the tie line layer. Since the data of related address for each parcel is not available on the Open Data Catalogue. Much of the time were spent on gathering related address for this layer. For more comments of data availability, please go to Challenges.

Business Licence – 2017 & 2018

The business license layer is a point layer that consists of business licenses in the study area. This layer is important to provide information such as: (1) predominant business type, (2) location of dense business license. The business types are in accordance with the definition in the Licence By-Law No.4450.

Data source:

Data came from the City of Vancouver's Open Data Catalogue business license package.

Data processing:

The business licence data was sorted and filtered in Excel to display data only for non-housing licenses in the study area (DTES). Business license data with coordinates were plotted in ArcGIS Pro using the provided latitude and longitude attributes. The "Delete Duplicate" tool in Quantum GIS was used to delete duplicate records from the business licence data. The "Point Disperse" tool in Quantum GIS was used to disperse overlapping license points for easier visualization.

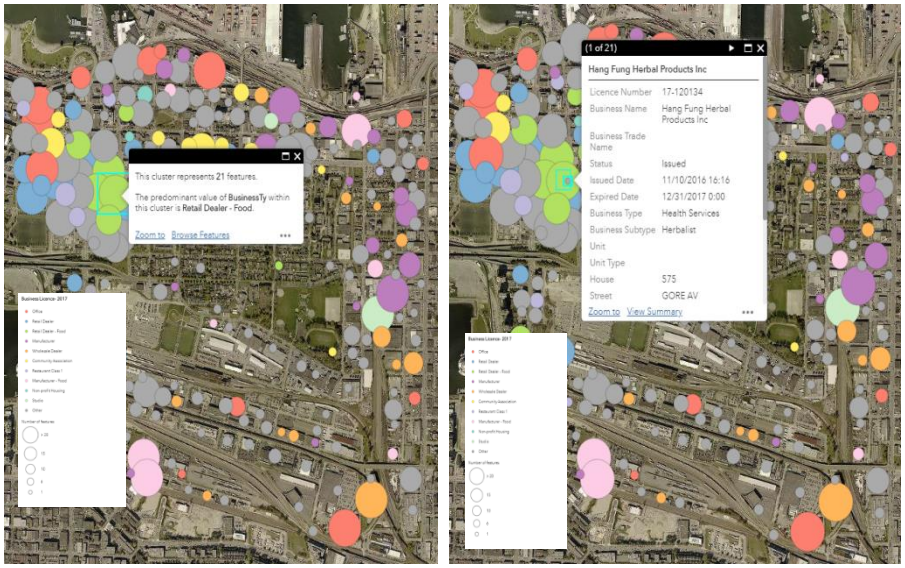

Figure 10. Example of the display of business licence. Left: Example of pop-up of initial cluster. Right: Example of pop-up for business licence for each cluster.

Display method and Rationale:

The business license layer was displayed as clustering points with pop-up. Points that are close in distance will display as one cluster. When zoomed in, clusters will disappear and each individual business license point will be visible. Points are categorized based on the top 10 business types using different colours. The pop-up attribute field shows the number of licenses within the cluster and the predominant business type. The clustering display method was used as it can better visualize as large set of data and to show the general trend.

Remarks:

There were around 600 categories for business types and this scale is too fine for visualization. For this version of the app, we decided to use the top 10 business type for visualization. For future projects, it is advised to group those 600 categories into a coarser scale for a more inclusive visualization.

Lease Rate- Heat Map & Points

Lease rate consist of two layers, a heat map and a point layer. Both layer contain information of lease rate in the V6A postal code area. Lease rate can provided information such as the trend of leasing cost, and the location of high leasing activities.

Data acquisition:

Information collected from Spacelist and other real estate agency from May 20, 2018 to August 1, 2018. A total of 68 points were collected through this period.

Data processing:

Points were creating on ArcGIS Pro using the “Edit” tool for each point collected.

Remarks:

The data availability of leasing information is limited and Spacelist only contains current leasing information. Thus, this layer needs to be regularly updated to capture all information available and to contribute to data analyzing. For more information on data availability, go to challenges and recommendation.

Figure 11. Example of the display of lease rate in heat map.

Display method and Rationale:

Heat map

A heat map is a spatial representation of data that uses colour coding to show where there is a density of record. This layer allows users to easily identify where there is a high intensity of leasing.

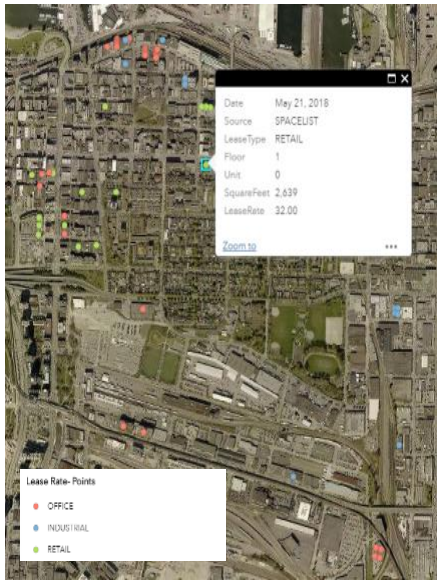

Figure 12. Example of the display of lease rate in points.

Point Layer

Point data will show the location of each lease rate point collected with lease type category. The pop-up attribute will show the date acquired data source, lease type, floor, unit, square feet, and lease rate.

Building Footprint

The building footprint layer is a polygon layer that shows generalized building footprints of the city that was generated from LiDAR data captured in 2009.

Data source:

Data collected from the City of Vancouver's Open Data Catalogue building footprints package.

Data processing:

"Clip" tool from ArcGIS Pro was used to extract building footprints for the study area.

Display method and rationale:

The building footprint layer was displayed as a transparent grey coloured polygon. This display was chosen as this layer will mainly serve as a background and this display would not distract users from navigating other layers.

Remark:

This layer should only be used as a reference. As this layer was generated using LiDAR data captured in 2009, changes in building footprint since 2009 are not reflected. Once there are new LiDAR data available, this layer should be updated using the newly generated building footprint layer.

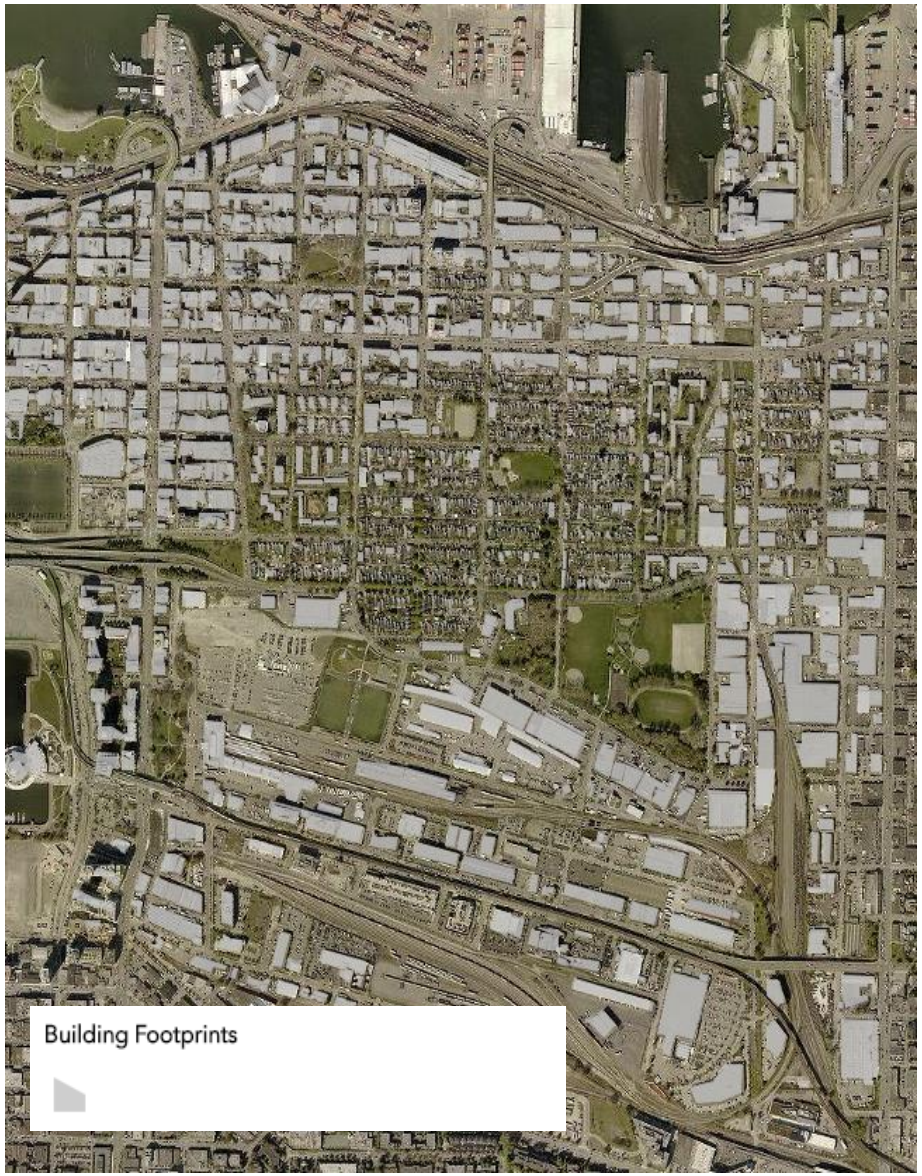

Figure 13. Example of the display of building footprints on CIRES Web Map Application.

Study Area

The study area layer is a polygon layer that outlines the boundary of the V6A postal code and consists of two socio-economic variables of the area: (1) median income and (2) median age of the V6A postal code. The use of socio-economic variables is for CIRES to understand the general demographic of its portfolio over time.

Data Source:

Data came from the 2016 population census data from Statistics Canada.

Data processing:

The study area polygon was created using the “Create Feature” tool in ArcGIS Pro. “Add Field” tool was then used to add two fields (median income and median age) in the attribute table. “Calculate Field” tool was then used to add variables for each field.

Display Method and Rationale:

The study area layer was displayed as a polygon layer with pop-up enabled. The polygon layer was modified to a transparent grey colour and moved to the background, allowing users to continue navigate other layers while having the study area boundary as a reference at all times. Enabling the pop-up allows users to check the values of both median income and median age in the pop-up box. (See Figure X for an example of the layer’s display and pop-up box)

Figure 14. Example of the display of study area on CIRES Web Map Application.

Web Application Creation

This application makes use of the Web AppBuilder for ArcGIS from ESRI to build an efficient and easy to use interface for CIRES.

The Web AppBuilding for ArcGIS is an application that allows users to build web applications with minimum uses of coding. It also allows users to build an application with widgets, customizable themes and layouts, and the ability to host apps online. The coding language of use is Arcade which is used exclusively with ESRI's product. Arcade was used in the creation of this web app mainly to configure pop-ups and to show related records.

This application makes use of the Web AppBuilder for ArcGIS from ESRI to build an efficient and easy to use interface for CIRES and the public.

Widget Used

Widget Used

About

Provides information about the app and a general description of CIRES

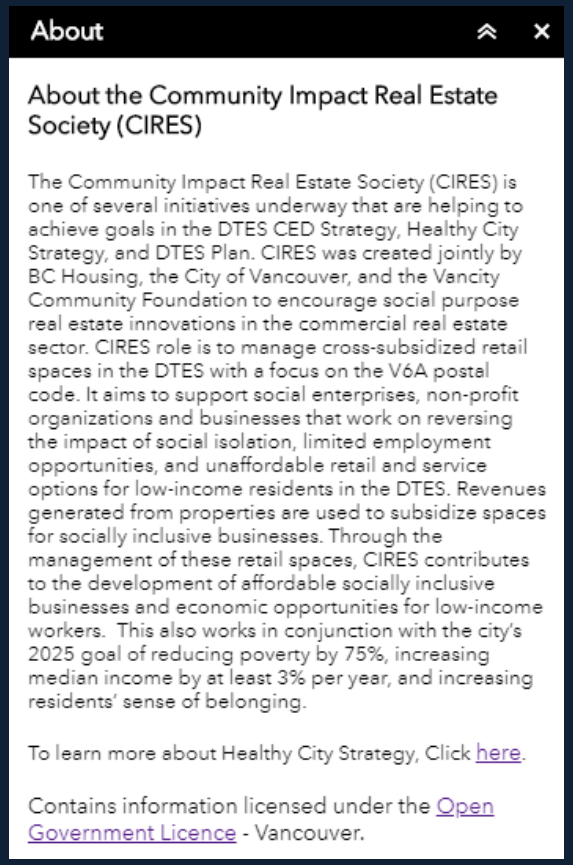

Figure 15. Example of the display of the about widget.

Legend

Displays the labels and symbols for each enabled layer in the map

Figure 16. Example of the display of the legend widget.

Layer List

Provides a list of layers and enables end users to turn layers on and off using the check box

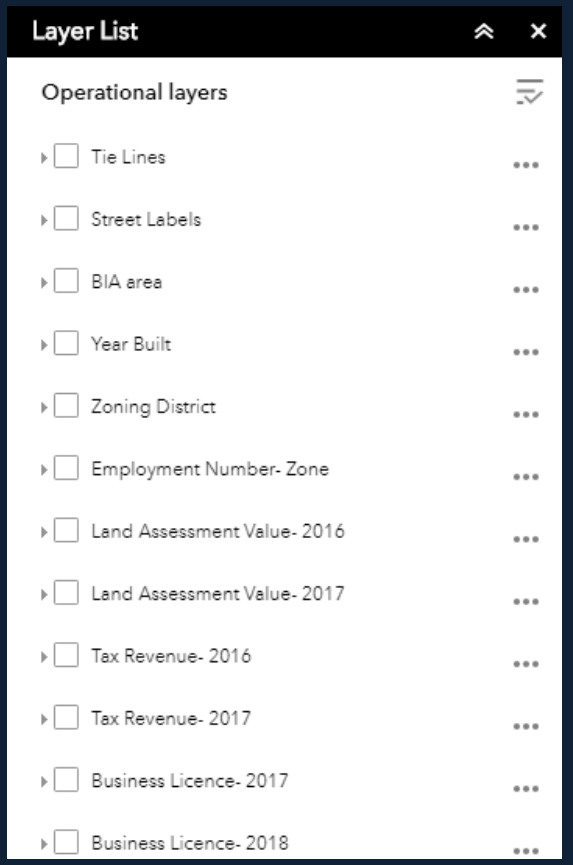

Figure 17. Example of the display of the layer list widget.

Widget Used

Add Data

Enables end users to add data to the map by searching for layers in ArcGIS online, entering URLs, or uploading local files

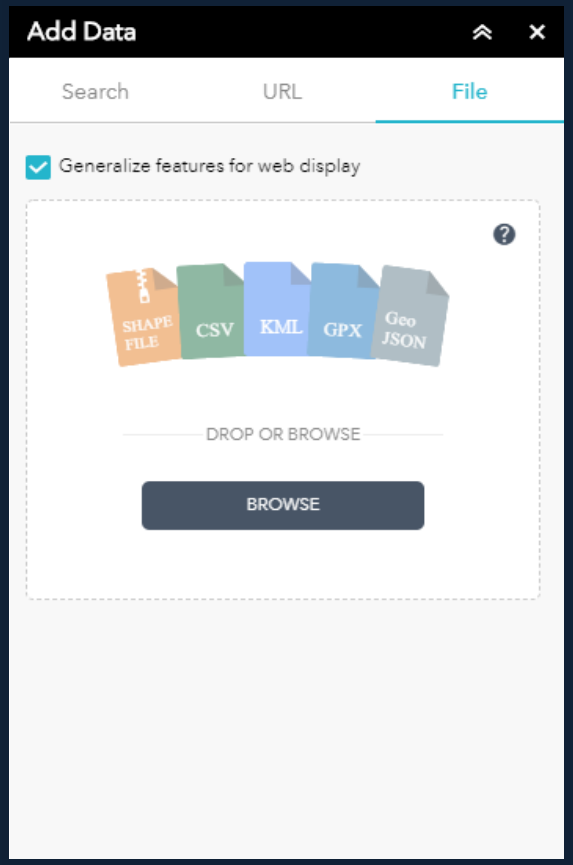

Figure 18. Example of the display of the add data widget.

Measure

Enables end users to measure the length of a line, the area of a polygon, and the location of a point

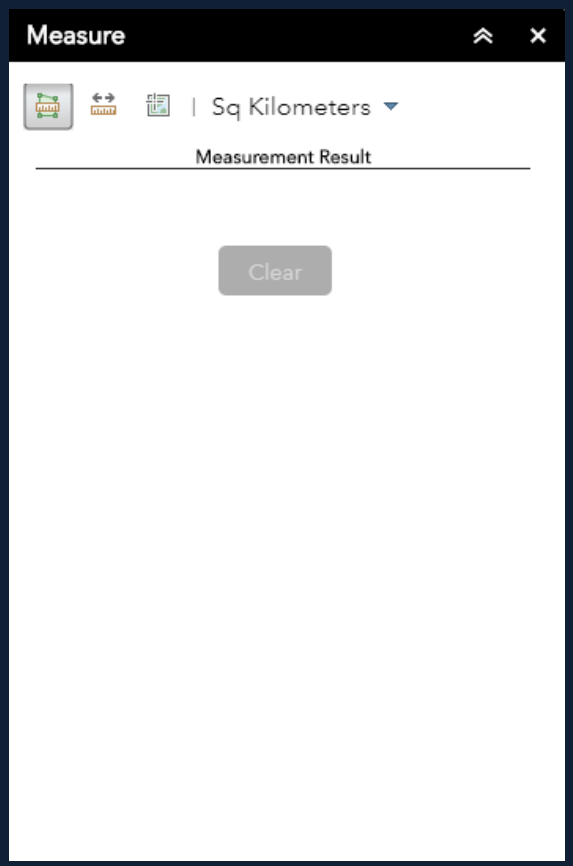

Figure 19. Example of the display of the measure widget.

Share

Enables end users to share the app publicly using URL provided or through social media accounts

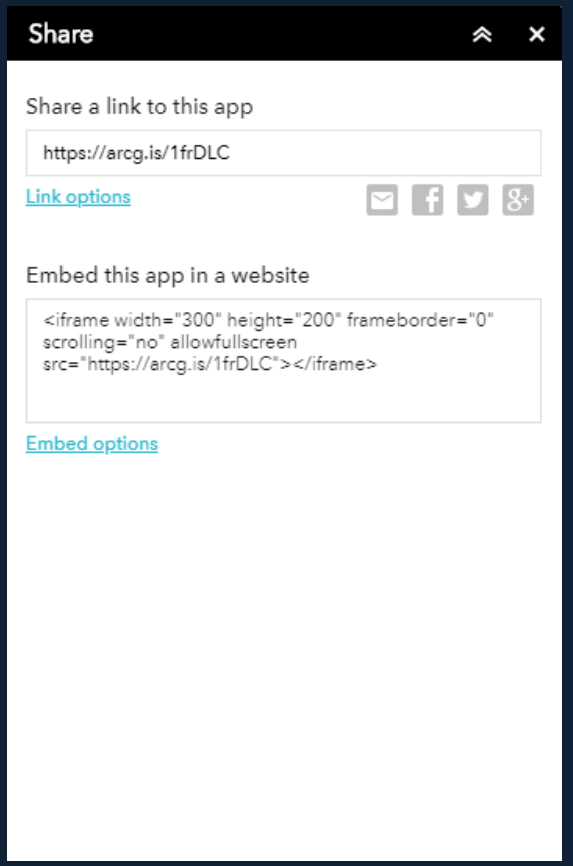

Figure 20. Example of the display of the share widget.

Widget Used

Time Slider

Enables end users to view temporal layers and control the animation of the data with buttons to play and pause

Figure 15. Example of the display of the about widget.

Help

Describe the use of each widget and includes additional help links

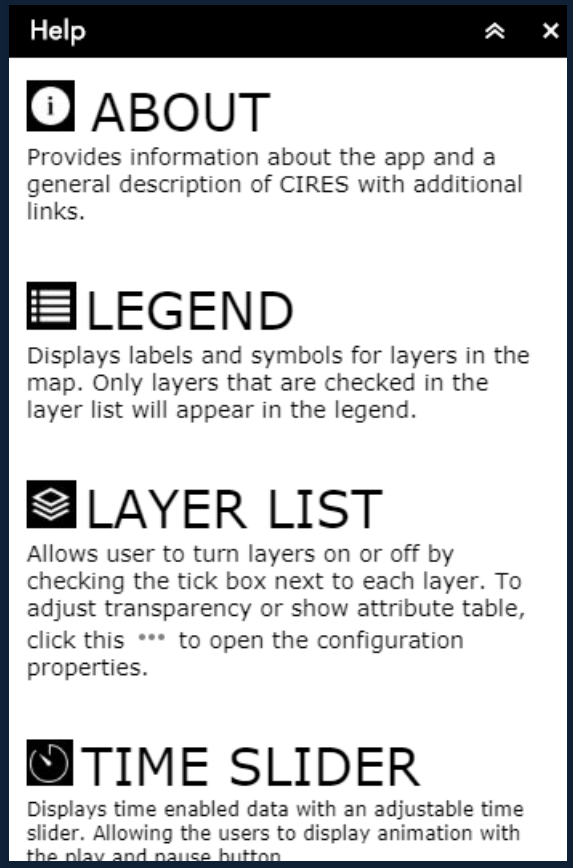

Figure 16. Example of the display of the legend widget.

Basemap

Enables end users to choose the desire basemap from the gallery.

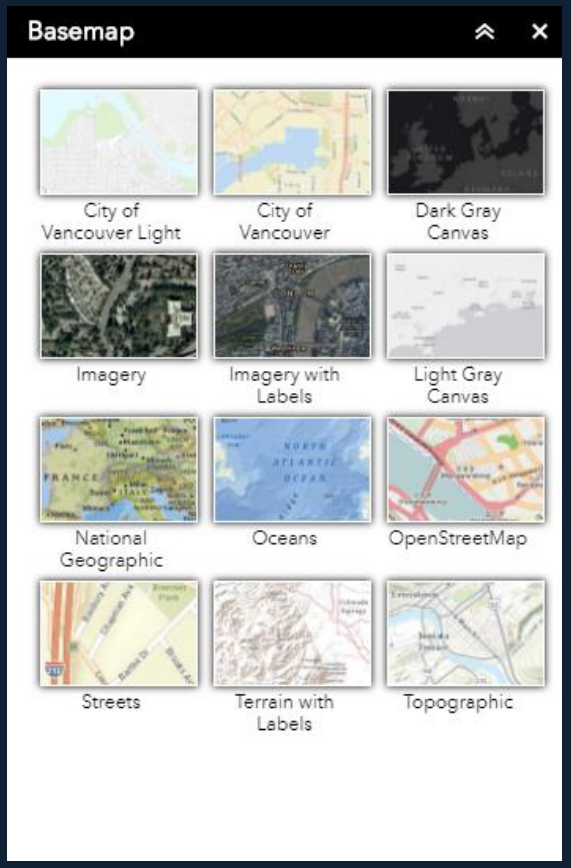

Figure 17. Example of the display of the layer list widget.

Challenges

Several obstacles were encountered during development of the CIRES Web Map application. Listed below are the two main challenges that had a significant impact on which data was included and how the application was built. These aspects should be taken into account when designing future updates.

Constraints of ArcGIS Pro

The cleaning and processing of spatial data requires a variety of advanced geoprocessing tools. Being able to process data in one program is important in order to be efficient and to keep data organized. The license that was provided for this project was the basic ArcGIS Pro license. This license allows users to process data with significantly fewer tools compared to the advanced or standard license. For example, essential tools for this project such as “displace marker”, “make a relationship class,” “delete identical,” and “symmetric difference” are not available in the basic license of ArcGIS Pro. Investment in a higher-grade license such as the advanced license will be of great help to increase productivity for future projects that involve a similar data processing workload.

Data availability

The availability of the data greatly affected the progress of this project and added uncertainty to the project timeline. Of particular note are the lease rate and parcel addresses data, which led to delays, as they took a lot of time to pre-process, adding significantly to the workload. Unfortunately, these kinds of delays are often unpredictable and don’t emerge until the actual data processing takes place. Future projects that require a different dataset should research and process the data before setting up a project plan timeline.

Key Decision Points

A few key decisions helped shape the application and influenced how the current application was built

For security purposes, private data were not included as a public layer in the final product of the CIRES Web Map application. A separate layer was processed and created with ArcGIS Pro and stored as a zipped file in CIRES's private folder. Given privacy consideration, CIRES will need to add the separate data layer to the web application each time when they want to analyze with this dataset.

For this project, a GIS application license is needed. After comparing the costs of different GIS applications and considering the frequency of use by CIRES, it was determined that it would be best to utilize the ArcGIS Pro license available through the City of Vancouver. The ArcGIS Pro license and an ArcGIS online account are needed to create a public online interactive mapping application for CIRES.

For some records, the data for the year built and business license contains null data. Of the year built dataset, 7% of the currently vacant parcels records contain null data. Those 7% of null data mainly includes vacant parcels, parks, bridges, and roads. We decided the effect of these null data is negligible, thus keeping all the original data. For business licenses, there are a total of 3% null data. As some selected business types such as home business's address data is undisclosed in order to protect privacy. Since those selected business types are usually home business and are not renting spaces, we decided that this is not an important variable for CIRES. This 3% of null data does not include the extraneous residential data deleted through data processing.

Use of the CIRES Web Map Application

The CIRES Web Map Application was created for the Community Impact Real Estate Society (CIRES). By showing a snapshot of the geographic data in the V6A postal code area, this app aims to provide a baseline of space, uses, and metrics of CIRES's retail portfolio.

Incorporating layers such as lease rate and business licenses allow CIRES to have a better understanding of the general trend of renting cost and the type and location of where businesses are populated. Using spatial visualization of data such as heat map, CIRES can easily spot where business activities levels are high, as well as their location and proximity. A set of socio-economic variables such as median income and median age can provide an understanding of the general demographic of the area. This is very important as they are the potential users of space and services in this area.

When the data is updated in the future, trends such as commercial leasing rate, fluctuation of tax revenues, and employment growth can be generated and analyzed. In conclusion, this web map application is created for CIRES for the use of easy data manipulation and data analyzing, and aid in a data-driven decision making.

Link to the CIRES Web Map Application: https://arcg.is/0z5Cf0