CHAPTER 6

Examining the Value of Geospatial Open Data

Sarah Greene and Claus Rinner

Abstract

Transparency, accountability, administrative efficiency, and economic development are the common motivations for making government datasets publicly available. Open data often include geographic references and may be offered in formats ready to be processed in geographic information systems (GIS). The present research contributes to assessing the value of these geospatial open data. We focus on the economic-development goal of municipal open data programs, the available file formats, and their innovation potential. In a case study of four major Canadian cities, we analyze the thematic distribution and the prevalence of GIS-ready data files among available open datasets. For the City of Toronto, we also examine access statistics for the most popular open datasets and their use in developing digital products. The results of this research suggest that political, administrative, and public support for the future maintenance and expansion of open data may require strategic releases of datasets that demonstrably support the stated goals of the respective open data initiative.

Acknowledgements

This research was partially funded by the Social Sciences and Humanities Research Council of Canada through the Geothink partnership grant.

1. Research Context

Open data are provided by different levels of government and can be freely used and redistributed by anyone (Sadiq & Indulska, 2017). They are available to private-sector companies, NGOs, journalists, researchers, and citizens through web-based portals (Johnson, 2016). These portals make the data available without delay, usually with no registration required, and in a number of different formats, the selection of which often depends on the resources available to the specific government organization (Johnson, 2016). Common open data file formats include Adobe PDF for reports, Microsoft Excel for spreadsheets, and Esri shapefile or Google KML for geospatial data (Baculi & Rinner, 2014; Wilson & Cong 2020). Location information is estimated to be present in 80% of all government and industry datasets, and open data are no exception (Baculi et al., 2017). Johnson et al. (2017) present a thorough analysis of the implications of open data practices on civic participation, geographic coverage, and private-sector relations, implications that are most pronounced in regard to geospatial datasets. In this chapter, we examine the contribution of geospatial open data to the value of the expanding open data initiatives worldwide. Research on the value of open data is necessary to understand their prospects and guide their development.

The discussion of open data in the scientific literature is linked to the recent evolution of e-governance and Web 2.0. As defined by Deloitte Research (2000, p. 1), e-governance is "the use of technology to enhance the access to and delivery of government services to benefit citizens, business partners and employees." This ties in with the Web 2.0 evolution, which brought about two-way communication and collaboration within and between governments, as well as with the public (Rinner et al., 2008; Sandoval-Almazan & Gil-Garcia, 2012). Open data catalogues are an increasingly popular format for the sharing of data, due to the end user's ability to download the data with ease, quickly, and at no cost (Borzacchiello & Craglia, 2012). Although there are no direct costs involved, there are secondary factors to be considered, such as the need for an Internet connection to view and/or use the data that can exclude some users from being able to access the information (Sieber & Johnson, 2015). Further, there are additional barriers toward accessing open data, which may exclude some users due to a lack of knowledge of available datasets or how the data can be used. This is particularly true for geospatial open data that require

specialized geographic information system (GIS) software to be processed (Baculi et al., 2017). In this context, Coetzee et al. (2020) note that open data are often integrated with other components of open information sharing, including open source software, open hardware, open standards, open education, and open science. Of the three types of open geospatial data distinguished by Coetzee et al. (2020, p. 1), "collaboratively contributed, authoritative and scientific," we focus on authoritative datasets in this chapter—that is, those generated by or for public administration.

In theory, open data can provide significant benefits to government and citizens through a number of avenues. By providing data openly, government agencies aim to increase transparency, enhance administrative efficiency, and promote economic development (Pereira et al., 2017; Zeleti & Ojo, 2017). Transparency and accountability are among the most widely discussed goals of open data (Robinson & Johnson, 2016; Martin & Begany, 2017). These goals focus on enhancing the relationship between government and citizens, including an emphasis on sharing information before being asked (Scassa, 2015)—the "open by default" approach. Drawing economic benefits from open data involves creating innovative applications, which can be used to help solve everyday problems (Graves & Hendler, 2013; Scassa, 2015). These applications then contribute to the common good through two possible pathways: (1) increasing government efficiency and innovation at the local level, and/or (2) creating monetary gains through the sales of applications, which increases tax revenues (Scassa, 2015).

Municipalities are introducing open data programs with the promise of increased resident engagement, which can then be combined with innovative activities to create new opportunities for residents and government. A cyclical process is usually described, where governments hope that residents will engage with open data, downloading them to further manipulate and reuse (Scassa, 2015). However, many municipalities have discovered that having an open data portal may not be sufficient to engage residents in using the data (Johnson, 2016). This is where civic hackathons have played an important role in connecting residents and private-sector companies more closely to the open data (Johnson & Robinson, 2014). Civic hackathons are events run by governments, which encourage the public to use open data to create different products, mainly under the category of mobile or web-based applications (Johnson & Robinson, 2014; Sieber &

Johnson, 2015; Robinson & Johnson, 2016). These hackathons encourage residents and private-sector companies to download and use open data, increasing the popularity of open data portals. They usually focus on solving everyday problems to improve residents' lives, and can result in applications that provide the creators with monetary gains (Robinson & Johnson, 2016).

The diverse benefits that drive open data programs should be considered in determining whether such programs are successful (Sieber & Johnson, 2015; Thorsby et al., 2017). Among these factors, promoting economic development is arguably the easiest to quantify. Open data create opportunities for citizens, private-sector companies, and NGOs to create innovative products and encourage them to be involved in entrepreneurial activities, which can help the local community as a whole (Sieber & Johnson, 2015). The emerging economic benefits are then brought back to government through taxes, job creation, and service improvements (Janssen et al., 2012). The broader theme of economic development focuses on driving innovation. This has been outlined as an important aspect of open data by both the Cities of Toronto and Edmonton (City of Edmonton, 2017; City of Toronto, 2017). Increasing opportunities for innovation is therefore seen as an important focus within municipal governments, while open data programs are seen as a way to achieve this goal.

Throughout the literature, there are a number of varying opinions on the value of certain open data file formats over others. Some claim that data provided in a spatial format are less "open" as their use requires a specific skill set and more expensive software (Janssen et al., 2012; Chan et al., 2016; Thorsby et al., 2017). Others argue that geospatial file formats are more valuable, as they can be used to visualize data in an interesting and captivating way, leading to potential economic development through the creation of map-based applications (Janssen & Zuiderwijk, 2014; Robinson & Johnson, 2016). As for non-spatial open data, they have been found to serve an important role in increasing accountability and transparency between governments and residents, building trust, and leading to greater participation and collaboration (Thorsby et al., 2017).

The present research contributes to the objective of assessing the value of open data. We surmise that attempts to assign a financial or social value to open data must consider the goals of an open data program, and the usability and de facto usage of published datasets. We therefore focus on the stated economic-development goal of many

open data programs and the role of geospatial data. Using a case study of four major Canadian cities, we analyze the thematic distribution and the prevalence of geospatial data among available open datasets. For the City of Toronto, specifically, we were also able to assess access to its most popular open datasets and their use in developing digital products.

2. Data and Methods

2.1 Study Area

In Canada, open data became prominent following its success in countries such as the United States and the United Kingdom (Vogel, 2011). The momentum toward open data here picked up great speed, however, after the federal government developed an open government strategy, in March of 2011, and through the development of a national action plan on open government, in 2012, which encourages and supports governments of all levels in providing data openly to their citizens (Government of Canada, 2016; Gill & Corbett, 2017). Both of these plans outlined the importance of open data as a whole, including improving the availability of information, encouraging citizen participation in government, increasing professional and public integrity, improving public services, and improving efficiency throughout government operations (Government of Canada, 2016). As open data has continued to develop in Canada, there has been a focus at the municipal level, perhaps because local government is in the best position to connect and engage with residents. The pioneers of open data at the municipal level in Canada formed a working group, titled the G4, focused on sharing successes and ongoing problems with open data releases and supporting each other, as well as other municipalities considering the development of open data programs (Giggey, 2012). The G4 cities are Vancouver, Edmonton, Toronto, and Ottawa, and constitute the study area for this research. Their open data websites were started in either 2009 or 2010, and at the time of this survey, the sites were located at the following URLs (as at summer 2017):

- http://vancouver.ca/your-government/open data-catalogue.aspx
- https://data.edmonton.ca
- http://toronto.ca/open
- http://data.ottawa.ca

2.2 Data Collection for the G4 Cities

The open data catalogues of the G4 cities were reviewed by visiting their individual web portals and collecting two distinct statistics about the dataset themes and data file formats. This included the count of datasets by the nine thematic categories shown in Table 6.1. These were derived from the literature (Roy, 2014; Dong et al., 2017; Thorsby et al., 2017) and each dataset was represented once, through the theme that best described it.

Theme	Examples
Business	Food truck locations, business permits
Planning and Development	Ward boundaries, neighbourhood names, building permits
Parks, Recreation and Culture	Parks, recreation schedules, outdoor pool locations
Health, Public Safety and Legal	Crime statistics, parking tickets, food safety
Educational, Community and Social Services	School locations, 311 data, homeless shelters
Governmental Data	Meeting minutes, budgetary data, census data
Environmental	Garbage and recycling schedules, water main breaks
Transportation	Bus schedules
Infrastructure	Street network

Table 6.1. Open Data Themes and Examples of Corresponding Datasets. *Source*: Sarah Greene.

In terms of file formats, we understand "dataset" as an individual catalogue item, while a "data file" is the unit through which a dataset can be downloaded. A dataset will have at least one data file associated with it. The file formats available for each dataset were collected. The list of file formats included 35 entries, though the eight most frequently recorded formats were relatively consistent across the catalogues: CSV (comma-separated values file), DWG (Autodesk drawing format), GeoJSON (Geographic JSON), JSON (JavaScript Object Notation), KML/KMZ (keyhole markup language), SHP (Esri shapefile), XLS (Microsoft Excel spreadsheet), and XML (extensible markup language).

An important distinction for the purpose of this research is between spatial and non-spatial data files. More specifically, we classified the DEM (digital elevation model), DGN (design), DWG, ECW

(enhanced compression wavelet), GeoJSON, GeoRSS (Web feed including geographic features), GeoTIFF (georeferenced TIFF), GTFS (general transit feed specification), IMG/IGE (ERDAS IMAGINE image file format), KML/KMZ, LAS (lidar data), MrSID (georeferenced raster images), MultiPatch (Esri 3D format), SHP, SketchUp (3D model), and TIFF (tagged image file format) file formats as "GIS-ready" (Baculi et al., 2017), or ready to be loaded in GIS software and to be mapped and spatially analyzed. These data files include points such as school locations, lines such as road networks, or areas such as parks (Currie, 2013), as well as remotely sensed photos and images. In contrast, examples of other data files, offered in formats such as CSV, XLS, or XML, include budgetary information, annual reports, and event schedules. Geographic references are also often found in these spreadsheets and other formats, such as when addresses or latitude and longitude coordinates are included as text (Currie, 2013). However, those datasets were not considered GIS-ready for the purpose of this research, as they require further manipulation to be visualized and analyzed spatially.

2.3 Additional Data Collection and Analysis for the City of Toronto

To further assess the contribution of open data and the role of GIS-ready data files, a case study of the City of Toronto was undertaken. An evaluation index was created that focused on answering a number of questions related to the program goal of economic development. Based on the methodology used by the global Open Data Barometer (ODB, 2016), five of the above thematic categories are most closely associated with the ODB's "innovation" impact group:

- planning and development;
- transportation;
- infrastructure;
- crime; and
- business data.

These themes contribute to economic development because the data are being "commonly used in open data applications by entrepreneurs, or with significant value to enterprise" (ODB, 2016, p. 12). We used these groups to identify the potential contribution of GIS-ready open data to economic development in the City of Toronto.

A questionnaire-style set of criteria with evaluation scores was developed, as shown in Table 6.2.

Question	Response Score
1. What is the percentage of GIS-ready data files in the category of Innovation?	Less than 25% - 0 Between 25-50% - 3 Between 50-75% - 7 Greater than 75% - 10
2. Are innovation-related GIS-ready data files downloaded more often on average?	Below Average - 0 Average - 5 Above Average - 10
3. Are the webpages of innovation-related GIS-ready data files visited more often on average?	Below Average - 0 Average - 5 Above Average - 10
4. Of the products created by third-party users, how many can be considered a spatial product?	Less than 25% - 0 Between 25-50% - 3 Between 50-75% - 7 Greater than 75% - 10
Total Score	/40

Table 6.2. Evaluation of Potential Contribution of GIS-ready Open Data to Economic Development.
Source: Sarah Greene.

Question 1 of the evaluation was answered by calculating the total number of GIS-ready data files and dividing it by the total number of data files available within the City of Toronto's open data portal as at summer 2017. Questions 2 and 3 were answered by using web logs provided by the city. We obtained web-access statistics for the top 100 downloaded data files from the time period between January 1 and May 28, 2017. These data were reduced to 75 data files that fell under the innovation impact group defined by the ODB (2016). The data were provided in a spreadsheet that included each data file name, a description, and the number of times the file was visited and downloaded, as a data file could be viewed without being downloaded. Question 4 was answered by examining the gallery of products created by third-party users, which is included on the City of Toronto's open data portal. The products were provided as URLs to web pages, which either shared the product in question or linked to a page from where the product could be downloaded. These products were examined for spatial components, such as maps.

3. Analysis and Results

3.1 Data Formats and Themes in the G4 Cities' Open Data Catalogues

Across the G4 cities, each dataset had an average of over four associated data files, with great variation between the City of Toronto, with an average of just 1.3 files per dataset, and the City of Edmonton, with 5.8 files per dataset (see Table 6.3). The City of Vancouver provided the majority of their datasets in at least two different file formats. If a dataset was provided in a spreadsheet format, it was usually provided in both CSV and XLS format, while GIS-ready data were primarily provided in DWG, KML, and SHP format. Other common data formats included XML and JSON. Toronto's and the City of Ottawa's datasets varied significantly in the number of data files provided, ranging from only one to five or more different data files, including both GIS-ready and other data formats. Edmonton provided multiple data formats for each dataset uniformly throughout their catalogue. All non-spatial data were provided in eight different formats, which included spreadsheets and web-based services, while their spatial data were provided in GeoJSON, KML, and SHP, as well as spreadsheets (though the latter were not included in the GIS-ready category in this research).

City	Number of Datasets	Number of Data Files	Files per Dataset
Vancouver	284	597	2.1
Edmonton	774	4487	5.8
Toronto	248	312	1.3
Ottawa	129	460	3.6
TOTAL	1435	5856	4.1

Table 6.3. Counts of Datasets and Data Files for the G4 Cities.
Source: Sarah Greene.

Figure 6.1 provides an overview of the number of data files found within the nine identified themes described in the methodology. Overall, the category with the largest number of data files was government data. This included an array of topics, ranging from census data, budget information, and government staff-related details. The theme of education, community, and social services had the second

largest count of data files. These included community-based surveys, social services, and school-related information. The business category had the smallest number of data files, with business-related data being quite sparse across the municipalities.

In terms of the spatial categorization of open data by theme for the G4 cities, there were 1,103 GIS-ready data files, making up about 19% of the total number of data files. Conversely, data files that were not GIS-ready numbered 4,770, or over 80% of all data files. Across the G4 cities, only two themes had more GIS-ready data files than other formats: infrastructure (58%) and planning and development (just over 50%). In addition, three themes—recreation and culture (35%), environmental (25%), and transportation (20%)—had non-negligible proportions of GIS-ready data files. There were, however, at least some GIS-ready data files available in each of the nine themes.

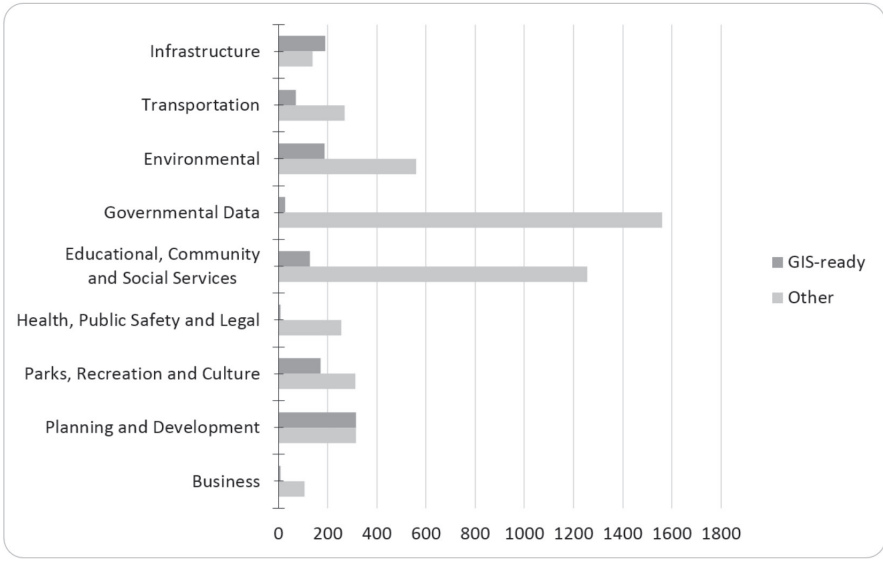

Figure 6.1. Number of GIS-ready Data Files compared to other Data Files by Theme.
Source: Sarah Greene.

Interestingly, innovation-related themes tended to have higher percentages of GIS-ready data files, with 35% of all innovation-related data being GIS-ready. There were 590 GIS-ready files in the innovation category, compared to 1,083 files that were not GIS-ready. In other

words, innovation-related data files that were GIS-ready made up more than half of all GIS-ready files (590 out of 1,103). The GIS-ready data formats were clearly associated with innovation in the G4 open data catalogues.

3.2 The City of Toronto's GIS-Ready Open Data

Within the City of Toronto's open data catalogue, 123 of 312 data files were classified within the category of innovation. While the percentage of GIS-ready data files among all Toronto's open data files was 28% (86 of 312), the percentage of GIS-ready data files within the innovation category was larger, at 33% (41 of 123). This led to a score of 3 for the first question of the evaluation.

To answer evaluation questions 2 and 3, the popularity of GIS-ready data files within the innovation category was assessed using the selection of 75 innovation-related files among Toronto's top 100 open data downloads. A large number, 45 of 75 data files (60%), were GIS-ready. Table 6.4 outlines the average number of downloads and webpage visits for the 75 data files, broken down by GIS-ready versus other data files. The average number of downloads per file during the study period was 387. The average number of downloads for GIS-ready data files was higher, at 436. This led to a score of 10 for question 2 of the evaluation. The number of downloads per data file ranged from 137 to 3,369. The five most-downloaded data files, as well as eight of the top 10, were classified as GIS-ready. The number of webpage visits for each data file ranged from 230 to 9,785 views. The overall average number of webpage visits was 1,992, while GIS-ready data files had a higher average of 2,238 views. This led to a score of 10 for question 3 of the evaluation.

	Average Downloads	Average Webpage Visits
Total Data Files	387	1992
Spatial Data Files	436	2238
Non-Spatial Data Files	318	1621

Table 6.4. Average Number of Downloads and Webpage visits per Innovation-related Toronto Data File over a six-month Period.
Source: Sarah Greene.

Some of the products created using the city's open data were presented in an online gallery within Toronto's open data website. This

gallery contained 51 different products as at summer 2017. Each product was examined to determine if it included a spatial component. This included products that used web maps and/or static maps to show information based on the dataset. We found that 33 out of 51 products could be considered as spatial. These included a number of mobile applications focused on transportation, a game, and online webpages providing analysis of a number of different topics. The non-spatial products totalled 18 out of 51 and mainly consisted of applications related to garbage and recycling schedules and/or reminders, along with applications highlighting upcoming events. The spatial products outweighed the non-spatial products, making up 65% of all those presented in the gallery. This led to a score of 7 for question 4 of the evaluation. A summary of this evaluation is shown in Table 6.5.

Question	Response Score
1. What is the percentage of GIS-ready data files in the category of Innovation?	Between 25-50% – 3 points
2. Are innovation-related GIS-ready data files downloaded more often on average?	Above Average – 10 points
3. Are the webpages of innovation-related GIS-ready data files visited more often on average?	Above Average – 10 points
4. Of the products created by third party users, how many can be considered a spatial product?	Between 50-75% – 7 points
Total Score	30/40 points

Table 6.5. Summary of Evaluation of the Potential Contribution of GIS-ready Open Data to Economic Development in Toronto.
Source: Sarah Greene.

Based on the results of the individual evaluation questions, GIS-ready open data are more prevalent within the theme of innovation. Further, the GIS-ready data files were downloaded and viewed at a higher rate than other data files. Additionally, the majority of the third-party products showcased by the City of Toronto included a spatial component.

4. Recommendations

4.1 Open Data in the G4 Cities

Between the G4 cities, there were significant differences in terms of the number of open datasets and their associated data files. However, there also were consistent patterns in the types of data files released with certain themes, and in the frequency of spatial versus non-spatial open data. Within the total number of datasets in the G4 catalogues, the categories of government data and education and of community and social services were most populated, and also consistently had more non-spatial data files. This may be related to the goal of government transparency and accountability, which many cities cite as the original purpose of creating an open data portal. The most common themes for GIS-ready open data were infrastructure, along with planning and development. These datasets revolve around technical information related to geography, such as political and administrative boundaries, roads, and building permits. Those who access these files will most likely wish to view them in a GIS environment. Further, many of these datasets can serve as base data, to be used with additional information to provide a bigger picture, such as when analyzing the location of child-care centres, while using roads as a point of reference to evaluate accessibility. It is clear that the value of spatial versus non-spatial data is heavily dependent on the individual end user's purpose in using the data.

When considering the high prevalence of non-GIS open data files in the G4 cities, it is important to note that even though many of these files included geographic references, such as latitude and longitude coordinates, they were not necessarily provided in a GIS-ready format. This can, for example, be the case for some of the CSV and JSON files present in the G4 data portals. In fact, Baculi et al. (2017) found that about 80% of open data files across Canadian municipalities included geographic references. These files can be used to produce valuable spatial products but may need to be further manipulated by a technical user in the appropriate software. A trade-off therefore occurs in the case of non-GIS data files that include spatial information, by potentially increasing the audience of a data file due to it being a less technical file type, while preventing some users from leveraging the full value of the dataset.

This trade-off ties back to the availability of different data files across datasets and between portals. There does not seem to be a standard in terms of the number or type of data files that should be released with a certain type of dataset. As the four open data programs examined in this study began at roughly the same time, the stage of development of an open data portal did not seem to have an impact on the data files available. The City of Edmonton's approach of uniformly releasing datasets in a fixed number and type of data files may help in terms of providing open data to meet the needs of all potential end users, but it does bring up the issue of staff resources needed for producing and uploading the various data files, as well as the storage space and network bandwidth needed to maintain the portal. By considering which data themes are more valuable in a spatial versus non-spatial format, along with considering which data files may complement one another, such as by providing CSV and SHP files for the same dataset, open data could be more strategically released to meet the needs of all end users.

4.2 The Contribution of GIS-Ready Open Data to Toronto's Economic Development

Based on the results of the evaluation, GIS-ready open data were found to have a higher prevalence within the theme of innovation for the City of Toronto's goal of economic development. The evaluation showed that GIS-ready data files were visited and downloaded at a higher rate than their frequency in the catalogue suggests. Interestingly, among the top data files, many of the non-GIS data files initially found in the list were accompanying files, such as "readme" files or other metadata, which were removed for the analysis. This further demonstrates the popularity of GIS-ready data files among open data end users. Additionally, the products created with the open data also tended to feature a spatial component, further proving the greater impact of geospatial open data. As the goal of economic development focuses on encouraging residents and private-sector companies to use the open data to create applications and other products, the data that are available to these end users should focus on content useful for creating applications, and also should be in a format that allows for these products to be created with ease.

By creating a gallery of products, the City of Toronto creates a connection with their open data users. Connecting with the end user

can allow government staff to better understand which data are being used and how they are used. The city may expect a dataset to be most valuable in one format, while the end users most inclined to interact with that dataset may find it valuable in formats not previously considered. By having an open and ongoing discussion with the public relating to their wants and needs, an open data program can focus on providing the right data in the most-needed file format(s). This research was shared with staff in the City of Toronto's Information & Technology Division in April 2018, while the city was in the process of developing a new open data portal to replace the open data catalogue accessed during this research. The new portal aims to "meet the unique needs of our users," with features including "flexible data formats" and "designed for technical and non-technical audiences" (City of Toronto, 2018a), which are supported by the results of this research.

Using the results of this study could help develop general guidelines toward releasing municipal information related to specific themes in certain data formats. Some effort could be undertaken in releasing existing data files in GIS-ready formats, where this is not already done systematically. More importantly, future releases of new datasets should be targeted to user needs. This may include, for example, releasing datasets within similar themes or taking a uniform approach to releasing data in a set number of file formats that complement one another. Generally, the proposed evaluation index can be used to help cities create strategic plans toward releasing open data, with a focus on geospatial open data, which have proven to support Toronto's economic-development goal.

4.3 Limitations of the Study

Based on the study area and the methodology used in this study, there are some limitations. Firstly, we only included the G4 cities, which have highly developed open data catalogues and, therefore, may yield different results compared to newer portals. Additionally, the results may have varied if a greater number of catalogues were assessed. In particular, the City of Edmonton had significantly more datasets and associated data files than the other three catalogues, which may have skewed the summary results. Further, municipalities may have varying responsibilities under different provincial regulations and procedures. For example, Ontario has numerous

municipal-level electricity-distribution companies, while other provinces have few or no utilities operating at the local level. The administrative unit within each city that operationalizes the open data program can also affect the focus of the program and the types of data released. This can lead to great variation between open data catalogues within a province or country.

Further limitations may be associated with the choice of criteria to assess the value of open data. The evaluation included only four survey questions. This was due to a lack of control over the data provided by the City of Toronto. The criteria provided robust questions for the limited sample data but this would be enhanced by more in-depth usage data. For example, there is a lack of knowledge of who is downloading or viewing open data, and what the data are used for. The City of Toronto has made some progress on the latter through showcasing some products in their online gallery, but this is likely only a small, non-representative sample of the products created with their data. This study is, therefore, a preliminary analysis of geospatial open data in the context of economic development, and has the potential to be further enhanced with additional data and evaluation criteria.

Finally, this research provides a snapshot as of summer 2017. Since then, the City of Toronto has developed an Open Data Master Plan and Roadmap (City of Toronto, 2018b), which guides the 2018–2022 development of their open data portal and related policies. Many aspects of the plan mesh with our findings, such as collaborating with potential end users in developing open data policies, pursuing an open by default principle, and strategically prioritizing dataset releases. In contrast to this research, economic development and facilitating "market opportunities" for the local economy (City of Toronto, 2018b, p. 26) appears as a secondary goal compared to a stated "focus on datasets to solve civic issues" and improving "City efficiency" (p. 5). While not mutually exclusive, the emphasis on civic society versus private-sector support will be subject to the political orientation of future city councils in Toronto and elsewhere.

5. Conclusions and Outlook

The consistent and ongoing evaluation of open data programs is key to maintaining existing programs and achieving the future success of open data. Further analysis of the value provided by geospatial

versus non-spatial data files should be undertaken at the municipal level, as well as for higher jurisdictions. Canada is composed of provinces and territories, each publishing their own open data. With its vast land mass, Canada is home to the first geographic information system ever created, the Canada GIS, established in the late 1960s to better manage the country's natural resources and agricultural lands (e.g., Goodchild, 2018). Geospatial data are particularly sensitive in the context of First Nations land management. The adoption of GIS to negotiate land allocations between First Nations in northern Canada was discussed by Duerden (1996) in the context of the Yukon land claims. (Issues of data sovereignty and Crown–First Nations relationships with respect to open data are discussed by Lauriault in Chapter 1 of this volume.)

A consistent approach to dealing with metadata, feeds, APIs, and data visualizations within government open data portals will be needed for replicable research. The proposed open data evaluation index should be refined as more comprehensive and detailed usage data become available in collaboration with municipalities. Qualitative, case-by-case research could investigate the circumstances under which apps and other open data-based products become successful, and how success should be defined in this context. It appears that municipal open data is becoming an established service, which is starting to go through improvement and reconceptualization cycles. The possible convergence of community-based open data such as OpenStreetMap with government open data such as road network files will further enrich open data ecosystems. We hope that this research will contribute to making open data programs even more valuable for users and, therefore, more sustainable in times of scarce government resources.

References

Baculi, E., & Rinner, C. (2014). A geographic content analysis of municipal open data catalogues across Canada. *Cartouche, Newsletter of the Canadian Cartographic Association*, *88*, Winter/Spring 2014, 8–9.

Baculi, E., Fast, V., & Rinner, C. (2017). The geospatial contents of municipal and regional open data catalogs in Canada. *Journal of the Urban and Regional Information Systems Association*, *28*(1), 39–48.

Borzacchiello, M. T., & Craglia, M. (2012). The impact of innovation of open access to spatial environmental information: A research strategy. *International Journal of Technology Management*, *60*(1/2), 114–129.

Chan, M., Johnson, P. A., & Shookner, M. (2016). Assessing the use of government open data and the role of data infomediaries: The case of Nova Scotia's community counts program. *eJournal of eDemocracy and Open Government*, *8*(1), 1–27.

City of Edmonton. (2017). *What is open data?* https://www.edmonton.ca/city_government/initiatives_innovation/open data.aspx

City of Toronto. (2017). *Open data master plan—update report*. http://www.toronto.ca/legdocs/mmis/2017/ex/bgrd/backgroundfile-102582.pdf

City of Toronto. (2018a). *The new open data portal*. https://www.toronto.ca/city-government/data-research-maps/open data/open data-portal/

City of Toronto. (2018b). *Open data master plan 2018–2022*. City council item EX30.12, Attachment 1. http://www.toronto.ca/legdocs/mmis/2018/ex/bgrd/backgroundfile-110740.pdf

Coetzee, S., Ivánová, I., Mitasova, H., & Brovelli, M. A. (2020). Open geospatial software and data: A review of the current state and a perspective into the future. *ISPRS International Journal of Geo-Information*, *9*(2), 90. https://doi.org/10.3390/ijgi9020090

Currie, L. J. (2013). *The role of Canadian municipal open data initiatives: A multi-city evaluation*. [Unpublished master's thesis]. Queen's University. https://datalibre.ca/2013/09/25/master-thesis-the-role-of-canadian-municipal-open data-initiatives-a-multi-city-evaluation/

Deloitte Research. (2000). *At the dawn of e-government: The citizen as customer* (A global public sector study). Deloitte Consulting.

Dong, H., Singh, G., Attri, A., & El Saddik, A. (2017). Open data-set of seven Canadian cities. *IEEE Access*, *5*, 530–543.

Duerden, F. (1996). Land allocation in comprehensive land claim agreements: The case of the Yukon land claim. *Applied Geography*, *16*(4), 279–288.

Giggey, R. (2012) *The G4: Setting city data free*. http://canadiangovernmentexecutive.ca/the-g4-setting-city-data-free/

Gill, M., & Corbett, J. (2017). Downscaling: Understanding the influence of open data initiatives in smaller and mid-sized cities in British Columbia, Canada. *The Canadian Geographer*, *61*(3), 346–359.

Goodchild, M. F. (2018). Reimagining the history of GIS. *Annals of GIS*, *24*(1), 1–8.

Government of Canada. (2016). *Canada's action plan on open government 2012-2014*. http://open.canada.ca/en/canadas-action-plan-open government

Graves, A., & Hendler, J. (2013). *Visualization tools for open government data* [Conference paper]. *Proceedings of the 14th Annual International Conference on Digital Government Research* (pp. 136–145). Association of Computing Machinery.

Janssen, M., Charalabidis, Y., & Zuiderwijk, A. (2012). Benefits, adoption barriers and myths of open data and open government. *Information Systems Management*, *29*(4), 258–268.

Janssen, M., & Zuiderwijk, A. (2014). Infomediary business models for connecting open data providers and users. *Social Science Computer Review*, *32*(5), 694–711.

Johnson, P. A., Sieber, R., Scassa, T., Stephens, M., & Robinson, P. (2017). The cost(s) of geospatial open data. *Transactions in GIS*, *21*(3), 434–445.

Johnson, P. (2016). Reflecting on the success of open data: How municipal government evaluates their open data programs. *International Journal of E-Planning Research*, *5*(3), 1–12.

Johnson, P., & Robinson, P. (2014). Civic hackathons: Innovation, procurement, or civic engagement? *Review of Policy Research*, *31*(4), 349–357.

Martin, E. G., & Begany, G. M. (2017). Opening government health data to the public: Benefits, challenges, and lessons learned from early innovators. *Journal of the American Medical Informatics Association*, *24*(2), 345–351.

Open Data Barometer (ODB). (2016). *ODB 4th edition methodology - v1.0*. World Wide Web Foundation. https://opendatabarometer.org/doc/4thEdition/ODB-4thEdition-Methodology.pdf

Pereira, G. V., Macadar, M. A., Luciano, E. M., & Testa, M. G. (2017). Delivering public value through open government data initiatives in a smart city context. *Information Systems Frontiers*, *19*(2), 213–229.

Rinner, C., Keßler, C., & Andrulis, S. (2008). The use of web 2.0 concepts to support deliberation in spatial decision-making. *Computers, Environment and Urban Systems*, *32*(5), 386–395.

Robinson, P. J., & Johnson, P. A. (2016). Civic hackathons: New terrain for local government-citizen interaction? *Urban Planning*, *1*(2), 65–74.

Roy, J. (2014). Open data and open governance in Canada: A critical examination of new opportunities and old tensions. *Future Internet*, *6*(3), 414–432.

Sadiq, S., & Indulska, M. (2017). Open data: Quality over quantity. *International Journal of Information Management*, *37*(3), 150–154.

Sandoval-Almazan, R., & Gil-Garcia, J. R. (2012). Are government Internet portals evolving towards more interaction, participation, and collaboration? Revisiting the rhetoric of e-government among municipalities. *Government Information Quarterly*, *29*(S1), S72–S81.

Scassa, T. (2015). Public transit data through an intellectual property lens: Lessons about open data. *Fordham Urban Law Journal*, *41*(5), 1759–1810.

Sieber, R. E., & Johnson, P. A. (2015). Civic open data at a crossroads: Dominant models and current challenges. *Government Information Quarterly*, *32*(3), 308–315.

Thorsby, J., Stowers, G. N. L., Wolslegel, K., & Tumbuan, E. (2017). Understanding the content and features of open data portals in American cities. *Government Information Quarterly*, *34*(1), 53–61.

Vogel, L. (2011). The secret's in: Open data is a foreign concept in Canada. *Canadian Medical Association Journal*, *183*(7), E375–376.

Wilson, B., & Cong, C. (2020). A survey of municipal open data repositories in the U.S. *International Journal of E-Planning Research*, *9*(4), 1–22. http://doi.org/10.4018/IJEPR.2020100101

Zeleti, F. A., & Ojo, A. (2017). Open data value capability architecture. *Information Systems Frontiers*, *19*(2), 337–360.

About the Authors

Sarah Greene completed a bachelor's degree in Environmental Studies at the University of Waterloo and a master's degree in Spatial Analysis (MSA) at Ryerson University. Both her undergraduate co-op placement and her master's research dealt with open data in Canada. This chapter is based on her major research paper in the MSA program. She completed her MSA practicum placement as a Data Development intern at Environics Analytics, where she is now a Senior Research Associate.

Claus Rinner is a Professor in the Department of Geography and Environmental Studies at Ryerson University. His research expertise within geographic information science includes participatory GIS and spatial decision support. More recently, he became interested in open geospatial data and 3D-printed geographies. He teaches in Ryerson's BA in Geographic Analysis and Master of Spatial Analysis programs.