NEW RESOURCES FOR SMART FOOD RETAIL MAPPING A GIS AND THE OPEN SOURCE PERSPECTIVE

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ABSTRACT

In this paper it is demonstrated that open-source GIS software may contribute to allow non-profit organizations and local food retailers to strategically locate food shops. This impacts realtors and other businesses as well. Areas are covered and clients served avoiding food deserts and increasing security in the health sector (Barnes *et al.*, 2016).

The methodology demonstrates how mapping may be processed, allowing people to get a good understanding of the food distribution. Also, decision making at corporate level improves due to better connecting to local production and organic retailers and to better reach out to local consumption. A major consequence of this exercise is likewise to educate users on the negative impacts of food deserts on health and improve awareness supporting the design and integration of sustainable and healthy lifestyles (Vaz and Zhao, 2016).

This novel proposal that combines spatial and locational data visualization (McIver, 2003), as well as sharing of information of healthy food retailers within the urban nexus (Morgan and Sonnino, 2010) engage communities actively to participate in the integration of new consumer behaviours and make them clearly expressed.

Keywords: GIS Open Source, Food Retail, Smart Food.

JEL Classification: R11, R32, R58.

1. INTRODUCTION

The importance of open-source geographic information systems is that it aids in the research process that applies to many disciplines, such as food security (Ruiz-Garcia, 2010). Open-source software can display a map in a variety of different forms for decision support (MacEachren *et al.*, 2004) highlighting and emphasizing different relationships between socio-economic variables, land use at urban level (Vaz and Arsanjani, 2016). In this sense, understanding the spatially-explicit interactions of different variables in regards to food security and quality at urban level is utmost importance to create securer and healthier cities (Twiss *et al.*, 2011). Concentration of the spatial relation with food retailers and the socio-economic habits, and the linkage of healthy, affordable grocery stores, good food markets, and farmer's markets should be a crucial part of the smart cities paradigm (Caragliu *et al.*, 2011). By integrating geovisualization techniques (McEachren *et al.*, 2004; Chen and Clark, 2016), the ability to define opportunities for food retailers to locate into food deserts in Toronto neighbourhoods is investigated. This is of particular importance given Toronto's significant urban growth in the last decades (Vaz and Arsanjani, 2015). Additionally, the chance for food retail businesses to profit from the rise and awareness of the food security moment is integrated. Many government agencies, not-for-profit organizations, and research

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institutions are the main stakeholders in trying to advocate and solve the problem of the large amounts of food insecure households and individuals in a food-rich nation like Canada. The research institutions and government agencies such as Toronto Public Health or Food Secure Canada have already developed resources for food retail mapping (Larsen and Gilliland, 2008). Nevertheless, it is the not-profit-organizations who run good food markets and function based on grants and donations in Toronto that particularly need to gain an interest in GIS and open-source mapping software (Brudney *et al.*, 2016). With the knowledge of open-source GIS software non-profit organizations and local food retailers can research or coordinate where to locate and expand organizations, or urban agriculture to a neighbourhood. The execution of strategically placing healthy and affordable food retailers not only involves a municipal or environmental planner, but impacts realtors and other businesses in the surrounding area by means of avoiding food deserts, which comprise a serious burden to the health sector (Barnes *et al.*, 2016).

The importance of mapping allows one to communicate and visualize data that may be difficult to understand when displayed in statistics or raw data (Fraser Taylor and Caquard, 2006). The versatility and practicality that comes from mapping enables people to distinguish the relationship between land and data as well as to acquire a clearer understanding of the topological distribution which interacts with decision making. In this sense, community mapping may support several relevant socio-economic instances such as: (i) supporting local production and organic retailers with selling points, (ii) reach out to the consumers on the importance of local consumption for sustainable development, (iii) educate users on the negative impacts of food deserts on health, (iv) create consumer aware communities supporting the design and integration of sustainable and healthy lifesyles (Vaz and Zhao, 2016). The ubiquitous nature of these tasks is achieved by means of the technocentric combination of spatial and locational data visualization (McIver, 2003), as well as sharing of information of healthy food retailers within the urban nexus (Morgan and Sonnino, 2010). The necessary integration of volunteered geographic information (VGI) within information dissemination is paramount (Gouveia and Fonseca, 2008), as communities can thus become actively engaged and participate in the integration of new consumer behaviours.

2. THE ROLE OF OPEN-SOURCE GEOGRAPHIC INFORMATION SYSTEMS

The influence of open-source Geographic Information Systems on food justice has proven its success over the past and future to enhance many aspects of a business such as the decision-making process, consulting and in marketing (Pettygrove and Ghose, 2016). Open-source software is widely applicable and can enhance performance and profit for businesses in real-estate, insurance, and banking or financial services (Perens, 1999). However, an open-source geographic information system can offer more for businesses and organizations connected to alleviating food insecurity in Canada (Chen and Che, 2001). Open-source GIS is referred to as a software that is accessible because it is free in the sense that the source code is available for anyone to modify, redistribute and view. Open-source software is very accessible, as in it can be viewed on internet browsers, or downloaded to desktops. A common misunderstanding is the competence of how the program or software; the sequence of commands, tools, and process that influence the outcome of the computer. Open-source GIS can translate the source code, resulting in the program running efficiently and fostering continuous improvement (Neteler and Mitasova, 2013). It especially benefits the public, but some open-source software may not be readily available in terms of data, but as long as the trend of open-source GIS continues to grow, so will the advocacy for spatial data to be more accessible for the public (Roberts *et al.*, 2006).

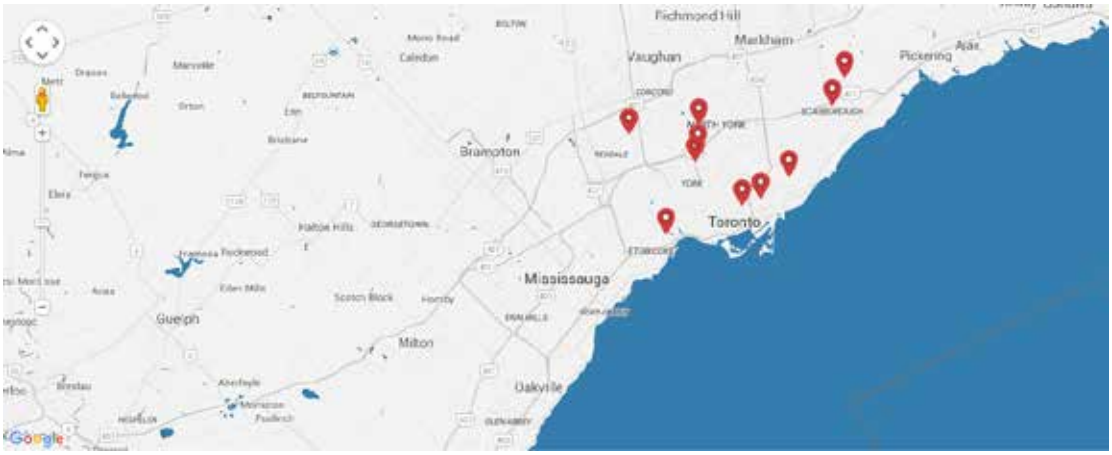
The difference between open-source GIS and closed source software such as ArcGIS is that a community approach is what allows the operation and development of open-source software to grow. Open-source software is a unique platform when compared to commercial proprietary software because the opportunity to modify the source code and create other works and research projects is possible. The advantage of choosing open-source over closed source software is that a closed source software offers a design that cannot be changed. If needs are not being met, the better option would be an open-source approach. To identify as open source software, a program needs to not have the source code and copyright information hidden (Camara & Onsrud, 2004). Also, under the licensing requirements the program cannot be copyrighted, giving the opportunity for anyone to run the software in any way they please which is unique because of the rules and regulations behind licensing and the source code (Camara & Onsrud, 2004). As previously mentioned, the open-source approach has a large community influence that is responsible for contributing to the original creators work by improvements that are made and errors being fixed. The support from a community of programmers is beneficial because it allows for people from different backgrounds to develop the software together relatively quickly. Some individuals are involved in open-source software to gain experience in technical skills, or continuing strengthening the open-source movement. The opportunity to engage and attract individuals who are from different backgrounds, and work of a variety of organizations such as food security works towards developing open-source software. With people who may not have the education in mapping or even technical skills can still bring new information and ideas to the scene of open-source.

3. COMMERCIAL VERSUS OPEN SOURCE GIS SOLUTIONS FOR FOOD RETAIL

Many present examples that Toronto Public Health uses to depict food retail environments in Toronto are produced with commercial GIS software. The usability and easy integration of commercial GIS software, despite the difference in cost, promote the preference of these solutions. Nevertheless, cost-efficiency for small and non-profit organisation is an important benchmark for preferring open source GIS, where licensing of commercial software is not always feasible and has significant budgetary constraints. In this sense, open-source GIS not only refers to the software that can visualize maps on different applications, but pertains to open-source geospatial libraries that can offer integrated solutions for data visualization as well as data analysis. The Geospatial Data Abstraction Library (GDAL/OGR) is popular since its functions includes converting and translating raster and vector data formats. Open layers for instance, is an interesting open source solution for spatial food analytics, given it simplicity of implementation and rapid result driven environment, which allow for visualization and interactive integration of spatial data components. OpenLayers corresponds to a JavaScript-based web mapping application framework that allows access to various data sources such as OGC services, commercial providers (e.g. Google, Microsoft, and Yahoo), and various data formats and protocols, making it possible to integrate a plethora of different geographical components and merging a significant number of different scales of analytics. For example, FoodShare (http://foodshare.net/) is a not-for-profit organization that strives to enhance healthy food through education in schools and communities In 2015, it served 6,370 lbs of produce grown in schools, supported 775 nutrition programs, and distributed 2,215,879 lbs of fresh vegetables and fruit. Additionally, Good Food Markets are examples of food retailers who can benefit from mapping through open-source software because many of the owners who run these mobile markets may not have received or even heard of Geographic Information Systems before. Furthermore, members who are new to the community and are using services such as sharing a plot garden or going to a food market; maps can be very

useful to a new migrant where English is not their mother tongue. FoodShare currently maps on good food markets within Toronto using an OpenLayers JavaScript application for instance (Figure 1).

Figure 1. Mapping of Good Food Markets



Source: http://foodshare.net/program/markets/

Common open-source software refers to programs such as GRASS GIS, MapWindow GIS, QGIS, and SAGA GIS. MapServer is an example of an open-source software that functions with a client (client-centric server) and server dynamic (server-centric server). Additionally, MapServer's architecture is what makes it stand out due to a three-tier approach, consisting of a hybrid structure of a balanced client-server. GRASS GIS is an innovative open-source software because until recently, public access to exposure of map visualizations and browsing was not common. Open-source is appealing and multifaceted because different types of open-source GIS can even be accessed through web browsers due to Java and HTML. This brings a significant potential for open-source software for serving to alleviate food security in metropolitan areas, particularly in the City of Toronto is a unique strategy that can be widely applied to different individuals and organizations. As the availability of smart phone devices with increased location precision grows, such initiatives are bound to bring significant innovation to identifying food security within urban areas. Together with issues reported by environmental injustice, a different scope of injustices preceding food security that is a growing concern within Toronto's urban landscape (Vaz *et al.*, 2017). The issue addresses a variety of different constituents that come from different backgrounds; ranging from income, ethnicities, gender and more. Toronto's goals primarily focus on increasing access to food, and solving the problems of health-related issues (chronic, disease, obesity), food safety and environmental pollution.

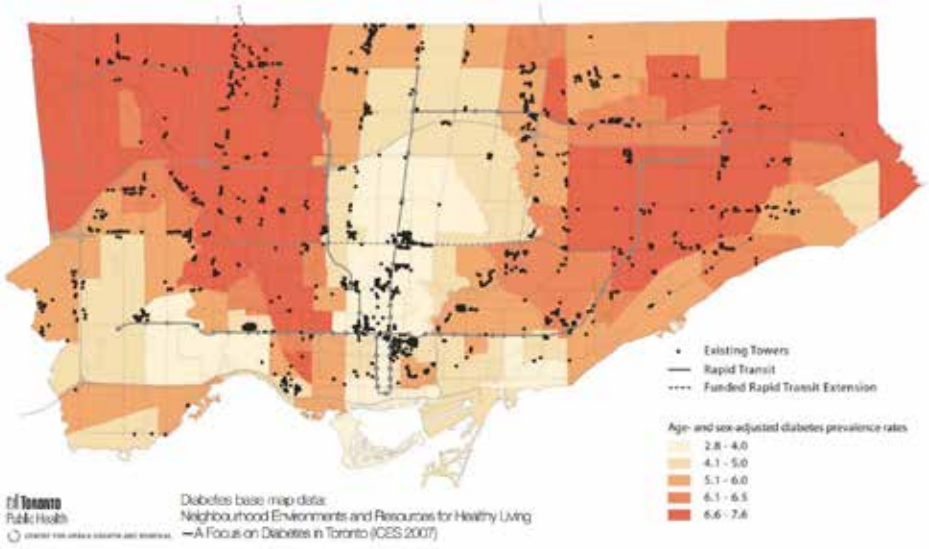
Since the principles of food security are interdisciplinary, the need for open-source software is accrued by the importance of incorporating the amount of efforts that certain organizations and food retailers are working on to solve the prevailing issue of food security (Pinstrup-Andersen, 2009). The use of open-source software aids in the research process in understanding relationships between social, economic, and environmental factors relating to geographic distribution that presents food insecure neighbourhoods, areas, and wards within the city. Open-source GIS depicts the spatial relationships related to identifying food deserts, which are referred to as areas that do not have accessible healthy or affordable food retailers, resulting in residents shopping at nearby convenience stores that offer expensive and low quality food.

Additionally, the rise of food retailers such as farmers' markets and good food markets are trending and can be found throughout the city. The occasion to integrate open-source software with the abundance of potential food retailers to visually display where the markets are located can inform the public, policy makers, and other organizations about the food options within their neighbours. Specifically, food deserts are of areas of concerns in neighbourhoods such as Flemingdon Park, South Riverdale, and throughout East York Toronto. Using open-source software to explore the correlations between food deserts, and where to find healthy food retailers in a neighbourhood are identified. But, another opportunity arises for business involved in food because once considerations are made on where the lack or abundance of healthy food retailers are located, the chance to determine where a food retailer show locate are supported.

4. TORONTO'S FOOD STRATEGY

Current food projects in Toronto are underway as Toronto is being recognized as a leader in urban agriculture and food security. Recently, Toronto along with other global cities signed the Milan Urban Food Policy Pact and plan to continue the awareness and improvement of Toronto's food security. The occasion for expanding the skills, practice and knowledge of open-source GIS is crucial for the future. The Toronto Food Strategy is a unique approach to food that understands the problems in relation to the current food system- high environmental costs, poverty in a food rich nation, obesity, accessibility and other related growing diseases. The strategy for improving the current food system considers and understands the importance of partnerships with a variety of stakeholders such as private industries, government and community agencies, and institutions. The Food Retail Environment Mapping is a unique project that is underway to analyze the research that maps provide on food deserts and other factors such as landscape, income, and neighbourhood (Toronto Public Health, 2015).

Figure 2. Post-War Apartment Towers and Areas of Incidence of Diabetes Across Toronto



Source: Toronto Public Health, 2012

Notably, what stands out once relationships have been discovered from maps about Toronto's landscape and its impact on food accessibility is that the next step is the planning process. Landscape and urban planning factors such as ravines, lakes, corridors, proximity

of major highways impact food accessibility; preventing people from available healthy, fresh food. The opportunity for food retailers to locate themselves in identified food deserts would be beneficial to alleviating food insecurity among low income households or individuals who are subjected to shopping at expensive convenience stores. This leads to concerns on the inequalities within neighbourhoods in Toronto, of interest to be monitored (Figure 2).

5. FUTURE IMPACT OF OPEN-SOURCE GIS FOR ALLEVIATING FOOD SECURITY

The City of Toronto demographics department has identified Neighbourhood Improve Area Profiles that represent many food deserts based on most low-income households, recent migrants, and community housing. Some food deserts that are also listed as neighbourhood improvement areas include South Parkdale, Black Creek, Regent Park and Victoria Park Village. To our knowledge, no organizations including government agencies have mapped out the relationship between the identified Neighbourhood Improvement Areas in relation to food insecure households and individuals. The process in improving a neighbourhood and how mapping is influential is when a food retailer has the knowledge to integrate technical skills through open-source GIS, and can than gain new knowledge about where a business such as a good food market would be most popular and attract as many consumers as possible. The mapping process may be intimidating to a local farmer, or stakeholder involved in a CSA program, which is a community supported agriculture program. It can also be frustrating when someone may want to expand their food business, but are incapable of knowing where to begin in the mapping process. Open-source software comes handy at that point; it is a great tool for starting out with GIS rather than a commercial, proprietary software that more government agencies use.

The opportunity for open-source GIS does not only apply to food retailers, but is interpedently related to urban agriculture, particularly green rooftops or community gardens. Private sector grocery stores such as Longo's, Loblaw's, No-frills as well as other food retailers are a part of the food retailing business. Larger corporations such as the ones listed have the network and already significant profits to invest in companies that specialize in GIS, or agencies that primarily use commercial software where they do the mapping on behalf of the company. On the other hand, good food markets such as Parkdale's Good Food Market, not-for-profit organization such as Cultivate Toronto and local, family food markets may not have the available funds to invest in food mapping for their business.

The option and availability of open-source GIS mapping gives people an opportunity through manuals, YouTube tutorials and forums of a shared community to gain skills in digital mapping for the benefit of spreading healthy, high-quality, nutritious food.

The options are endless for food retailers to expand their market through open-source software. Offering customers and consumers healthy, local food not only improves overall health of a population, but has a positive impact on reducing environmental pollution from creating a local, sustainable food system. The occasion to visually represent and communicate where the closest food retailer is located, nearest community garden, and competition of food related businesses can be produced through maps since different organizations offer community support agriculture programs, available free plots to grow food, food banks or co-ops, and food delivery of local, organic produce. In addition, food retailers who are more versatile in their business and not only provide the service of offering local, high-quality inexpensive food, but also is an organization that promotes educational advocacy can have the strongest benefit from mapping. For instance, "Mapping can be applied in specific

situations or projects, such as understanding the needs of a client group (i.e. Consumers or local farmers), or teaching school children about food issues.

Furthermore, the annual reports that businesses and organizations publish are missing a key aspect- a mapping element. Annual reports include information on grants, messages from the CEO and board members, employment, and projects or initiatives that the particular organization has been working towards. Evergreen Brickworks, Cultivate Toronto and Greenest City are examples of organizations that submit and distribute annual reports each year who work towards creating a stronger, local food system in Toronto. Based on my findings from exploring a variety of different annual reports, many of them are formatted similarly with figures, and statistics but nothing is measured in terms of visual maps.

6. CONCLUSION

Not only is there potential for food retailers, but the options are endless for visualizing food security opportunities. For instance, mapping green roofs, CSA programs, not-for-profit organizations and more can be visually depicted. Geographical food justice is singled out throughout the report, an emphasis on not-for-profit organizations that function based on grants and donations can benefit extremely from open-source software. Also, geographical food justice is a unique movement that can contribute to the improvement of food security. By incorporating and spreading the knowledge of open-source geographical information systems to people who work for a good food market, farmers' markets, community gardens, rooftop gardens, urban agriculture (Vaz *et al.*, 2014), and advocacy groups in food security, accessibility for food can be improved. Food security also operates within a community context, similarly to open-source software. The chance to grow the open-source software field by integrating it with food security and urban agriculture needs to occur. Particularly within the incremental risk of brown fields and the amassing of urban land use change (Loures and Vaz, 2016). Many individuals in the food security field come from diverse backgrounds, the results are worth noting and the future of open-source software can ultimately develop completely different new abilities if a new and diverse group of people join in on the ubiquitous nature of collective technological enhancement through smarter cities and regional intelligence (Vaz, 2016).

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