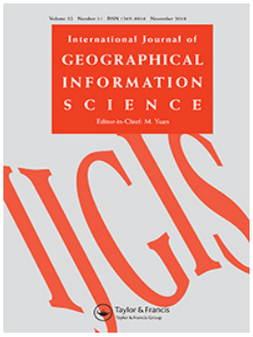

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RESEARCH ARTICLE

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Toward a participatory VGI methodology: crowdsourcing information on regional food assets

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ABSTRACT

Local knowledge has been underrepresented in food-related policies and planning. The goal of this research was to engage members of a local food community and generate volunteered geographic information (VGI) on community food assets. During active data collection, over 200 food assets were reported. This paper details the systematic approach used to create VGI, which emphasizes the socio-cultural context surrounding the mapping technology. The project began with an identified need to connect to and learn from the local food community. The participants were drawn from active food system stakeholders, and a Geoweb infrastructure was selected based on publicly available crowdsourcing tools. The resulting VGI is presented according to system functions: input (Web traffic, contributors, input types), management (contribution vetting, privacy), analysis (typology of input), and presentation (sharing the submitted data). Despite limitations, this study revealed a hyper-local and community-driven perspective on food assets, opened access to government and private data, and increased the transparency and accessibility of information on the regional food system. This research also revealed that there is a growing need for intermediaries who can bridge the gap between experts in the subject matter and experts in digitally enabled participation, and a need for non-government open data repositories.

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Public participation GIS; community engagement; food systems; urban applications

1. Introduction

The United Nations' Trade and Environmental Review emphasizes that strategies to build and maintain an adaptive and resilient food system require a shift from a conventional monoculture-based agri-industry to a collaborative approach for sustainable, regenerative food systems (Hoffmann 2013). This shift would require a shared vision (Knapp and Trainor 2013), one that creates space for a broader range of food system stakeholders to discuss problems, leverage resources and contribute to food system solutions (Baker *et al*. 2010). These stakeholders range from government and nongovernment agencies, academic and public service institutions to community groups and individuals – and can be socially, culturally, ecologically or politically oriented (Feagan 2007). There is no one definition for who is, or who is not, a food system stakeholder. Trying to ascertain who is,

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in fact, is problematic endeavor as some key groups do not even consider the impact of their actions on the wider food system. Rather, they are farmers, gardeners or business people who are going about their work or hobbies while contributing to their food system.

Collectively, this 'food community' is contributing to lasting and real change in what some consider a broken food system. According to Pothukuchi *et al*. (2002, p. 5), 'while most of these efforts are small-scale, they represent the seeds of creative and lasting solutions to food system problems.' These local and individualized efforts have the greatest impact of the food system when they can be connected (Nasr *et al*. 2010). Increasingly, Food Policy Councils (FPCs) have been commissioned to create regional food policies, plans and programs that are aligned with the community's food assets and gaps. As civic advisory groups, they work across sectors to advocate for coordinated food systems action at a local or regional level (Harper *et al*. 2009). However, and given the diverse food community operating at often hyper-local scales, a collaborative approach to supporting sustainable and regenerative food systems is no small task.

The Canadian Province of Ontario's Local Food Act identified digital and web technologies as a prospective, yet currently underdeveloped, avenue to support engagement and data creation within regional food systems (Bill 36 2013). Volunteered geographic information (VGI), in particular, has demonstrated the potential to support greater engagement and knowledge sharing across diverse people and subjects, such as environmental monitoring and disaster management (Elwood *et al*. 2012, Haworth 2016). Part of the broader phenomenon of crowdsourcing (Brabham 2009), VGI refers to user-generated contributions that contain a location component (Goodchild 2007, Sui *et al*. 2013, Campelo *et al*. 2017). The collection of this new type of geospatial data contributed by volunteers rather than official government agencies is sought after as a technique for broader citizen engagement (Lauriault and Mooney 2014, Corbett and Cochrane 2017).

Despite mounting evidence of the sustained value of VGI, there is still a poor understanding on how to create VGI using a methodologically rigorous process. How can a FPC – or an NGO, community group or individual researcher – generate VGI, in order to both engage and coordinate the local community, and capture this new source of information? This research applies a systematic approach for generating VGI to guide the process of gathering crowdsourced contributions from the active food community. Emerging from this process of systematic community data collection, this paper aims to capture the assets and actions of the local food community, while critically reflecting on the capacity for widespread stakeholder engagement under the VGI systems approach. Using Durham Region in Ontario, Canada, as case study, Section 2 outlines the VGI system components, Section 3 reports on the functions of the system, and Section 4 discusses the impact of the system on engaging the regional food community.

2. Building a VGI system using active and participatory methods

VGI has been associated with contributions that are both passive and active. Passive contributions are akin to geolocated social media (Stefanidis *et al*. 2011), censored

environments and spatial supports in big data (Robertson and Feick 2018), where active contributions are akin to digital humanitarianism (Burns 2018), citizen science (Haklay 2013) and community-based production of geographic information (Hall *et al*. 2010). The VGI systems method, developed by Fast and Rinner (2014) and applied in this study, was designed to create the latter: active or participatory VGI. Contributors are purposefully engaged in order to share (literally volunteer) content. Influenced by geographic information systems (Tomlinson 2007) and participatory methods (Sieber 2006), the VGI systems methodology shifts toward experiential and exploratory learning, requiring researcher and community to actively work together to achieve the desired result (Kearns 2005, Neumann *et al*. 2012).

The VGI systems approach expands the view of VGI beyond the mere consideration of the technical infrastructure and data collected to include the critical interconnections of the project goals and participants. This perspective echoes Chrisman's (1997) nested GIS schema, which was rooted in moving GIS beyond the 'input–processing–output' sequence to a process that addresses critical interconnections with the societal, cultural and institutional context. This interconnected approach is especially important for VGI, as developing a system based on community contributions amplifies existing 'demands and expectations of the human context [that] become intermingled with what seems to be technical decisions' (Chrisman 1997, p. vi). The social, cultural, institutional and technical context is integrated in the nested rings – the project, participants and Geoweb. These components then structure the input, management, analysis and presentation of crowdsourced content. In this paper, we also expand Fast and Rinner's (2014) perspective to include existing base data as part of the Geoweb infrastructure, as shown in Figure 1.

2.1. *Project: Durham food map*

The outer ring in the VGI systems schema (Figure 1) is the project. This methodological design overcomes the heavily criticized tendency to put the development or deployment of new technology ahead of the problem or desired solution. This project focuses on the Regional Municipality of Durham and its eight municipalities (Ajax, Brock, Clarington, Oshawa, Pickering, Scugog, Uxbridge and Whitby). The majority of land in the Region is designed as prime agricultural with large areas protected by the Ontario Greenbelt Plan (see Figure 2). However, large swaths of unprotected land are adjacent to the built-up areas; settlement pressures in the Region, exacerbated by the rapidly growing Greater Toronto Area to the West, are leading to an unprecedented loss of prime agriculture land. This growth threatens the Region's ability to produce its own food (Neptis Geoweb, 2018). Further, Durham's Health Neighbourhood study found that the consumption of fresh fruits and vegetables in the Region is lower than the provincial average, and identified inner-city neighborhoods as the most at-risk for unhealthy food consumption (Durham Region Health Department, 2016).

Durham Region is actively responding to the threat to agricultural land and prevalent food insecurity by way of the Durham Food Policy Council (DFPC). The DFPC is collectively committed to developing better food policy and programs to support a resilient regional food system. To gain a better understanding of the

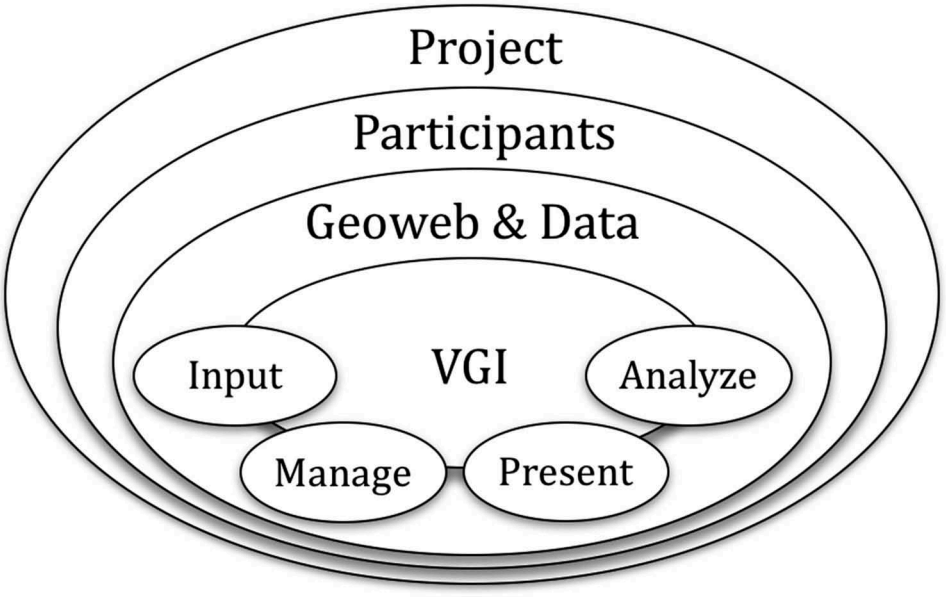

Figure 1. The VGI systems approach for structuring the collection of actively volunteered geographic information (modified from: Fast and Rinner 2014).

regional food system, the DFPC completed the Durham Food System Environmental Scan in 2013, herein referred to as the Durham Food Scan (Contreras-Judge 2013). The scan took an assets approach, which tends to cultivate community development, rather than a needs approach, which tends to lead to community dependence (Kretzmann and McKnight 1993). The assets, categorized by food processing, distribution, procurement, recycling and waste, and consumption, were evaluated according to their interaction with the biological, economic, political and social dimensions of the food system. The purpose of the report was to ensure that current and future food policy and planning accurately reflects, supports and builds on what is happening in the community (Contreras-Judge 2013).

While the scan provided key insights into Durham's food system, the major limitations identified by the DFPC were that it did not represented neighborhood- or community-level food assets. They lacked the appropriate resources and capacity to employ participatory methods or conduct a community-level scan, and were not able to connect and communicate with the multiplicity of actors operating in the regional food system. Building on the identified limitations of the Durham Food Scan, this project was developed in coordination with the core members of the DFPC. The DFPC served as an advisory committee, in which regular in-person meetings and email contact supported the framing of the problem and design of the data collection/mapping interface. As such, the broader project underlying this paper is centered on engaging various food system stakeholders in Durham Region to volunteer community-level content to supplement the Durham Food Scan findings.

An important consideration in establishing a VGI project is the time frame. While many notable examples of VGI projects are ongoing, including OpenStreetMap (OSM)

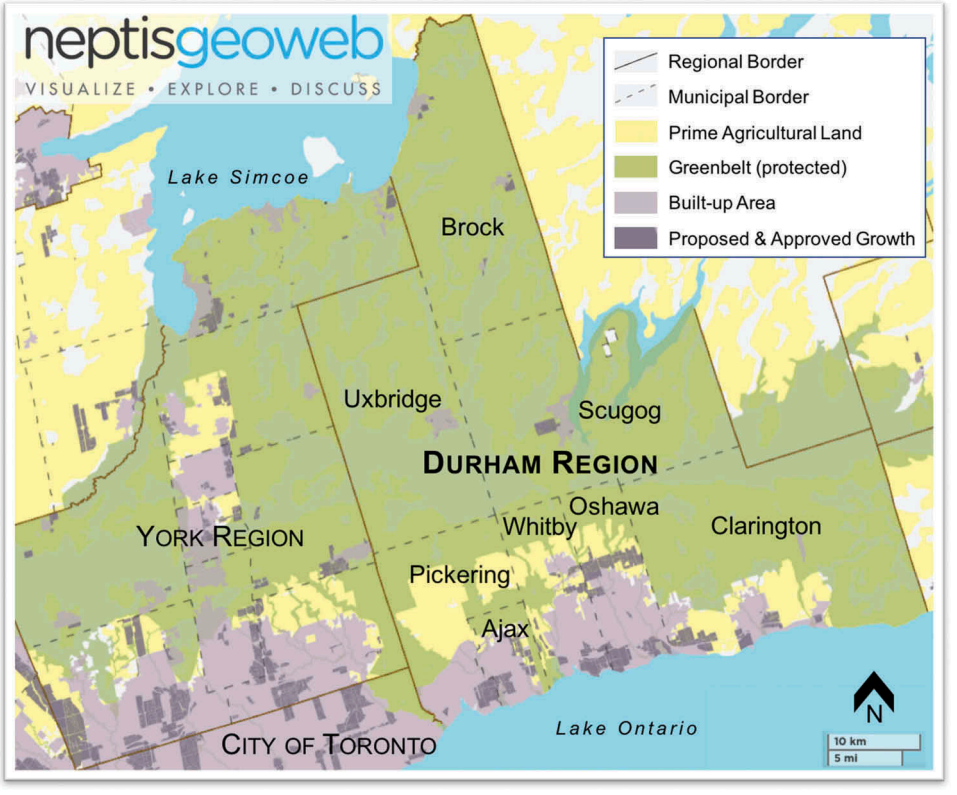

Figure 2. Urban expansion in Durham Region and its municipalities (source: Neptis Foundation, 2018).

and Wikimapia, staff and financial resources limit the operating time of most projects. A constrained time frame can help ensure the sustainable operation of a project. While there is no agreed upon time frame for a study such as this, Haklay (2014) identified 6–8 weeks as the ideal time frame of a problem-oriented project, with a minimum lead time of 3 months. Neis and Zipf (2012) also observed that the majority of OSM contributions occurred within 3 months of registration, before sharply declining. As such, the contribution time frame was limited to 5 months between January and May 2015.

2.2. *Participants: connecting to Durham's food community*

The challenge of the participant component in this VGI system was to connect to the existing efforts of a large number of food system stakeholders, and devise strategies to encourage their participation. The DFPC facilitated access to, and support from, a range of government, nongovernment, community and individual stakeholders that they identified as currently and actively involved in the local food system. In this approach, the participants in this study were gathered using a crowdsourced version of a snowball

sample; initial contact begins with groups and individuals most active in the local food community, and then outreach activities were designed to snowball to maximize reach to members of the broader food community.

The strategy for promoting participation consisted of in-person presentations, emails and video outreach activities. First, seven in-person presentations were arranged to introduce stakeholder groups with the goals of the 'Durham Food Map' project. Presentations were incorporated in the organizations' existing monthly or annual meeting schedules. The attendees of these presentations consisted of community volunteers (>80%) serving on various environment and food-related committees – representing government (e.g. Durham Environmental Advisory Committee) and community-led (e.g. Durham Integrated Growers) committees. Next, two mass emails were distributed to the DFPC email list. Last, a 3-min video, uploaded to YouTube was used to supplement the email and efficiently explain why participation was important.

In total, 28 key stakeholder groups involved in Durham's food system were invited to participate. They represented two joint government and citizen advisory groups; four regional government agencies; eight municipal government agencies; six nongovernmental agencies, representing the environmental, climate change and sustainability sectors; six community groups, broadly defined as being comprised by all volunteer work (i.e. no paid employees), compared to NGOs, which are more formalized organizations that have paid employee(s); and two postsecondary institutions (the names of these organizations are withheld according to the research ethics protocol for this study).

2.3. *Geoweb infrastructure and base data*

To proceed, we required a web mapping infrastructure, herein referred to as the Geoweb, that is capable of collecting actively volunteered map-based content – or VGI. The online mapping infrastructure required for this study was limited to free, online and hosted tools so that the project could be accessible to the community during and after the completion of this study. Geoweb options are constantly expanding and changing. Bartlett and Rivard (2014) compared nine free online mapping tools, including GeoCommons, MapBox and CARTO (formerly CartoDB).

2.3. 1. *Crowdmap*

After many considerations (and a thwarted attempt at creating a customized crowdsourcing tool), Crowdmap was chosen to support this project. Crowdmap is the hosted version of the Ushahidi platform (i.e. it does not require installation of the Ushahidi software on a local server), and was initially designed to gather reports from citizens in times of crisis (Okolloh 2009). Crowdmap offers many customization options, including options for base map data (OSM chosen), RSS feeds (all stakeholder websites added if they were RSS enabled), website appearance (title, tags and about pages) and various contribution input types, including reports, email, links and photo content options. The SMS input option (phone-based text messaging), available through Crowdmap, was not enabled for this project because detailed contributions were sought.

2.3.2. *Customizations*

It is important to acknowledge that the standard and customizable options available through Crowdmap shaped many of the functional considerations for the Durham Food Map. First, all contributions needed to be approved by administrators. In consultation with the DFPC, it was decided that all contributions were to be included on the map unless the contribution was incorrect or defamatory. The 'about this project' page of the map included consent information.

Crowdmap offers a public data download option to support the creation a food asset dataset that is accessible, usable, downloadable and archivable. The standard contribution form in Crowdmap contained fields for contributor first name, last name and email address, which is optional for the contributor. Approximately half of the contributors shared their personal information. However, these personal data could not be excluded from the public data download function in Crowdmap, so the download function was disabled to protect the privacy of individual contributors. A dedicated Durham Food Map email address was created for those wanting to ask questions or submit additional information. Contribution and participation rates were tracked using both Crowdmap's built-in analytics and Google Analytics.

2.3.3. *Base data*

Before gathering VGI, it is important to determine – find, gather, scrape with permission – what, if any, data already exist. In Durham, there is no open data infrastructure in place (yet, anyway). Lacking publicly available data on the regional food system, the Community Development Council of Durham generously volunteered the dataset generated from the Durham Food Scan. The dataset consisted of 130 data points and contained five categories: community gardens, community-shared agriculture farms, farmers' markets, food banks and supermarkets. The dataset attributes included latitude, longitude, name of asset, city and description. These data were uploaded to Crowdmap and used as the foundation of food assets in the region, as seed content has been shown to encourage crowd contributions in participatory Geoweb applications (Sani and Rinner 2011).

3. VGI system functions

In setting up the VGI system, the project was defined, the participants were recruited, the Geoweb tool was prepared for contributions, and existing data were uploaded. The functional considerations – organized as input, management, analysis and presentation – are used to report on the process of gathering VGI to support mapping Durham's regional food assets.

3.1. *Input: traffic, contributors and input type*

The first stage of collecting VGI was to get traffic from members of the local food community to the site. Google Analytics recorded 1011 sessions from 893 users during the 3-month time frame, excluding bounces, indicating that 88% of the sessions were by new users. Sessions peaked immediately following two mass email events. The initial email, sent after receiving approval from the DFPC on 15 March 2015, generated 134

new sessions. The email sent on 26 April 2015, a final reminder to contribute, generated the highest peak of 197 sessions in a single day.

In comparison to the high access rates, there was a low rate of active contributions. Based on a tally of those who contributed via email and an estimate of online contributors, approximately 23 unique participants contributed these data, mainly representing community groups. The 23 active contributors out of 893 unique users led to a participation rate of approximately 2.5%. As reported by Neis and Zielstra (2014), OSM demonstrates similarly skewed participation rates, with only 20,000 of the 1.3 million registered users, or approximately 1.5%, actively contributing VGI in 2013. Further, within the group of active contributors, there are significant differences in the level of activity, with the majority of contributors only being active for 3 months after registration (Neis and Zipf 2012). Given the 5-month time frame of this project, the 2.5% participation rate was likely the peak of participation. The January–May time frame proved adequate, although multiple contributions were received (and accepted) after the official data collection period ended.

The contributions can be divided into two input types: individual contributions (IC) and dataset contributions (DC). IC contained detailed information on individual community assets and were either added directly to the map or sent to the dedicated Durham Food Map email address. The DC, shared by two NGOs and one community group, consisted of private datasets generated in-house. All three stakeholder groups expressed an interest in increasing the accessibility of their information through the mapping interface. Unfortunately, they were unable to upload the data directly since Crowdmap did not have a batch-upload function. Instead, the datasets were delivered via email, manually cleaned of duplicate records, keeping the most up-to-date entries, and then uploaded to the Durham Food Map.

Overall, 227 unique data points were contributed in the course of this project, with 130 of them coming from the original Durham Food Scan dataset, meaning there were 97 new food assets reported by the local food community. These contributions were divided equally between IC and DC. The IC and DC – containing information on farms, farmers' markets, rooftop gardens, bee farms, public orchards and community gardens – were more detailed (e.g. containing attributes such as contact information, operating hours and produce available), up-to-date (e.g. two of the three datasets updated within 6 months) and complete (e.g. containing all of the farms and community gardens operating in 2015) than the initial Durham Food Scan dataset.

3.2. *Data management*

Various administrative considerations influenced the management of this VGI system, most notably, contribution vetting. In total, 54 of the 227 contributions received were not included on the map. This high vetting rate was attributed to different reasons than initially expected. Originally, the advisory committee discussed removing contributions that were incorrect or inappropriate. In practice, most contributions that did not make it to the map contained either sensitive or inadequate spatial information.

The vast majority of vetting occurred because the data contained sensitive spatial information. For example, in the Durham Food Scan dataset, the food banks category contained 45 entries. However, 22 of the 45 data points were excluded because they

contained information related to shelters and support services, which is not publicly available information (e.g. emergency women's shelters). The other 23 data points related to food banks were added to the map because this information is publicly available. Also, contributions that contained food assets reported at private residences were withheld to protect individual privacy.

Contributions were also excluded if they lacked adequate location information. All contributions added directly to the map were included, because the preset input options within the mapping application required contributors to include adequate spatial information. In contrast, only four of the eight contributions submitted via email were added to the map because the remainder did not contain adequate spatial information. For example, some contributions focused on a range of food strategies, rather than food assets, which does not lend itself to mapping because the strategies did not relate to a specific location. While the reported food strategies were not added to the map, they present key insights into the operationalization of food strategies and were incorporated into the dataset for further analysis.

The other main management consideration was compiling a single dataset from contributions that contains different data categories, attributes and metadata. Each contribution, whether an IC or a DC, required cleaning, combining and adding to a central database – described next.

3.3. *Analysis of data collected*

The relatively small number of contributors (n = 23) and contributions (n = 227) created a dataset that is not comprehensive of all food assets in the Region, nor is it continuously updated, which limits the capacity to conduct traditional spatial or statistical analysis – such as analysis of food deserts/swamps (e.g. Helbich *et al*. 2017), community interactions with the food environment (e.g. Widener *et al*. 2017) or urban growing capacity (e.g. Schneider and Fast 2017).

Instead, the data gathered contained detailed, and sometimes lengthy, accounts of food assets and the community's interaction with them. To organize the data and analyze the content, we first need to understand the type of contributions. Rinner and Fast (2015) established a typology of user contributions on the participatory Geoweb. The typology includes location, categorical and numeric data, descriptions, media and opinions. Prominent types, fields and subfields emerge from the contributions that are relevant to all data gathered in this study (Table 1).

The *location* was presented both as geometry (latitude/longitude) and address. When only the address was available, the geometry was geocoded from the address.

The *category* was the food asset, classified as Farm, Farmers' Market, Community Garden, Food Bank, Supermarket, Foodscape or Innovative Food Asset. The Innovative Food Asset category was meant to serve as an 'other' and contained some of the most unique contributions: pollinator gardens, seed libraries, neighborhood gardens, public fruit trees and urban food growing capacity (i.e. pounds of food per square foot). Overall, these contributions highlighted community-led, locally relevant food assets happening within the cities in Durham.

The *description* contained the name of the asset, other reported details (e.g. the type of products sold at a farm), and in 12 cases, a detailed story about the food asset. Some

Table 1. Typology of user contributions.

Typology	Field	Attributes
Location	Geometry	Latitude/longitude
	Address	Postal address
Category	Asset	Farm, farmers' market, community garden, food bank, supermarket, foodscape, innovative food asset
Description	Name	Business/feature name
	Details	Short description
Media	Links	Website, Twitter, Facebook
	Contact information	Name, email
	Photos	*Not included in dataset*
Metadata	Time stamp	Date data created
	Origin	Durham Food Scan, individual contribution, dataset contribution

stories contained hundreds of words and gave fantastic, open-ended accounts of how community members are using, supporting and championing local food assets. This type of largely qualitative and community-level data is more conducive to analysis techniques reserved for interviews, focus groups and community surveys. This type of analysis supports a context-rich understanding of the actors and actions within the regional food system.

The *media* volunteered contained contact information for more than 50% of the contributions, which contained links to related websites, Twitter and/or Facebook accounts. In three instances, the media refers to a local news story. Last, dozens of photos were shared, which included photos of the asset, of logos and of the community using the asset.

Expanding Rinner and Fast's (2015) typology, a *metadata* type was added. Metadata, defined as data about data, contain details related to who created the data, when the data were created (time stamp) and other data quality information, which helps to assess its fitness for use (Devillers *et al*. 2010). While there have been improvements in spatial data quality over the last 30 years, there are very little, if any, metadata associated with most crowdsourced datasets. Coleman (2010) noted that the lack of metadata in volunteered datasets – in particular, information on different and multiple sources of data – makes it challenging to identify why some data may be more accurate than others. Data integration becomes even more problematic when mixing authoritative and user-contributed dataset. In this study, in an attempt to capture the origin of data in the final dataset without identifying individual contributors, the origin field is generalized to the dataset it came from, which is sub-categorized IC or DC. On a similar privacy note, if an individual contributor could be identified from their affiliation, the affiliation was also removed.

3.4. *Presentation and sharing of data*

Following the active data collection phase of the project, focus shifted to presenting and sharing the food assets reported with the DFPC and the public. This presented a unique challenge because of the diverse data types. Sieber *et al*. (2016, p. 1031) describe these type of data as 'unstructured multimedia narratives not restricted to tuples and feature geometries'. Presenting and sharing multimedia narratives requires a medium that can

capture the story the contributors wanted to tell, while avoiding proprietary software requiring paid access, which is not within the budget of project partners such as the DFPC and most of the NGOs involved. CARTO, a free online mapping and data management platform, was used to present the Durham Food Map. The CARTO version of the Durham Food Map includes a cleaned dataset (minus exclusions) that visualizes the location of reported food assets and while enabling data download in multiple formats.

A report was also created for the DFPC to supplement the data and map. While maps play an important role to communicate the intricacies of a decentralized, interconnected and fundamentally spatial food system, the report can better capture the innovative food assets and summarize the narratives volunteered by the food community.

4. Discussion: engaging intermediaries and community data repositories

Overall, this research targeted a diverse set of local food stakeholders that represent government, NGOs, community groups and engaged community members. Individually, they possessed fragments of valuable information about the local food system in Durham, fragments that, put together, provided a dataset to better understand what food assets are important to the region. Putting the fragments together to realize VGI revealed two main findings: one, there is a growing need for intermediaries who can bridge the gap between experts in the subject matter (i.e. food stakeholders) and experts in digitally enabled participation (i.e. geographers, planners). And, two, there is an urgent need for data repositories for nongovernment open data.

This project required significant researcher involvement to generate or reveal fine-grain community-driven VGI. Despite data contributions occurring online, the researchers heavily mediated the cross-sector sharing of stories, resources and initiatives throughout the preliminary meetings, formal presentations, video and follow-up contact. The intermediary also processed, cleaned and managed the diverse data contributions. This role required familiarity of both the local food system and VGI techniques and procedure. Resulting from the unsustainable level of involvement of the researcher, the project suffers from distance decay, which limits opportunities to scale-up this project to provincial or federal food systems mapping. The 'researcher as intermediary' role is getting increased attention due to the significant mediation required to share and create data (see Fast and Rinner 2017). As such, it is important to further refine this role, and its effectiveness, especially in developing VGI systems to connect government, decision-makers and civil society.

In addition to the significant role of the intermediary, this project also required active involvement from participating food system stakeholders. Building on the relatively small number of contributors and findings that are not comprehensive of all food assets in the Region, the positionality of those who did contribute is of interest. In this study, active VGI contributions were most effective when trying to connect to an existing community who is actively, or at least interested, in collaboration. Particularly active engagement came from the NGO and community group participants, compared to the limited engagement from government stakeholders. The individuals within NGOs and community groups were more inclined to actively and meaningfully contribute data, both IC and DC. Many noted that they were already trying to work toward better collaboration (especially online) with other food system stakeholders, so the map

provided a medium to support their preexisting goals. Further, the NGOs and community groups had fewer restrictions to participating and sharing their data, enabling them to freely share their in-house datasets.

Data contributions from NGOs and community groups currently represent an underutilized source of (potentially open) data that warrants further investigation. Progress in the open data sphere over the last decade has focused almost exclusively on government data. In this study, the NGOs and community groups demonstrated they have data that they are willing and eager to share. There needs to be better infrastructure to support data sharing and VGI creation for nongovernment groups. Currently, the Provincial Health Services Authority and the Public Health Association of British Columbia, Canada, have a 'BC Food Security Gateway' (2018) that provides a centralized portal for provincial food-related projects, initiatives and organizations. While the gateway contains a resource catalogue and gives the public the option to contribute suitable and related resources, it falls short of serving as a data repository.

Thinking more broadly than food systems, open data need to extend beyond government to support knowledge exchange and collaboration across less formalized entities, such as NGO, community and research groups. Establishing a permanent data repository to host nongovernment open data is an important step to facilitating better collaboration through digital technologies. Data from NGOs, advocacy and community groups, and crowdsourcing projects can play an important role supporting collaboration and decision-making, if only we could teach the data to talk to each other.

5. Conclusion

This study established a VGI system to enable and engage multi-sector food stakeholders and create new information on regional food assets. It represents an attempt to move toward more systematic, controlled creation of VGI. The methodology explicates the project, participants, Geoweb and data components required to create VGI, while the functions structure the reporting of the input, management, analysis and presentation of VGI. The study resulted in the creation of a crowdsourced food assets dataset and an online map to communicate the intricacy of a decentralized, community-driven food system. The new data augment the knowledge of regional food decision-makers, highlighting food assets that are central and reported directly by the food community.

In addition to capturing and creating web map of community food assets in Durham Region, there are process benefits that are difficult to objectively report. The process of reaching out to stakeholders, hearing their stories, compiling their data and disseminating them back to the group facilitated the confluence of existing individual activities and a common goal of crowdsourcing information on local food assets. Kretzmann and McKnight (1993, p. 1) define this as 'building a community from the inside out.' By asking the stakeholder community about their assets, a uniquely local and inspiring story about the regional food system emerged. Durham residents are growing, sharing and eating locally grown food, thus contributing to growing of food and community.

Despite the growing understanding of the societal implications of VGI as a social practice (Elwood 2009, Elwood *et al*. 2012, Lin 2013), the challenge of measuring the tangible impact that VGI and participatory mapping techniques have on networking, advocacy, collaboration and engagement remains unquantified. According to Tomlinson

(2007, p. 3), 'most citizen sites don't use traditional metrics – unique visitors, page views or revenues – to measure their success.' Rather, success is more often determined by the impact the site has on the community. Given this, we suspect the impact of this research and engagement far surpassed the numbers reported above.

The community-centric reporting also reinforced that the VGI systems perspective is not exclusively about the crowdsourced data or the mapping technology employed; it is equally about the project and participants. In particular, the DFPC plays a central role in using these resources to support stronger food policy. While the scope of this study ends here, the primary recommendation moving forward is to mobilize the cross-sector network of engaged food stakeholders to develop locally relevant regional food policies, to be adopted by each municipality, that support a strong community-centered food system. The impact of this research on regional and municipal food policy, and the development of programs and regulations that come with it, will be determined through the continued commitment of the regional food community – both the official food policy stakeholders and everyone who shared their story.

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Disclosure statement

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References

Baker, L., Campsie, P., and Rabinowicz, K., 2010. *Menu 2020: ten good food ideas for Ontario*. Toronto: Metcalf Food Solutions.

Bartlett, R. and Rivard, J. 2014. Online mapping tools. Available from: https://www.library.carleton.ca/help/online-mapping-tools [Accessed May 1 2015].

Bill 36. 2013. Local Food Act, Pub. L. No. Bill 36; Chapter 7, Statutes of Ontario. Canada: 2nd session, 40th Legislature, Ontario.

Brabham, D.C., 2009. Crowdsourcing the public participation process for planning projects. *Planning Theory*, 8 (3), 242–262. doi:10.1177/1473095209104824

Burns, R., 2018. Datafying disaster: institutional framings of data production following superstorm sandy. *Annals of the American Association of Geographers*, 4452, 1–10. doi:10.1080/24694452.2017.1402673

Campelo, C.E.C., Bertolotto, M., and Corcoran, P., 2017. *Volunteered geographic information and the future of geospatial data*. Hershey, PA: IGI Global. doi:10.4018/978-1-5225-2446-5

Chrisman, N., 1997. *Exploring geographic information systems*. New York: John Wiley & Sons, Ed.

Coleman, D.J. 2010. Volunteered geographic information in spatial data infrastructure: an early look at opportunities and constraints. *In*: *GSDI 12 World Conference* 1–18. Available from: http://www.gsdi.org/gsdiconf/gsdi12/papers/905.pdf

Contreras-Judge, P. 2013. *Durham food system environmental scan: a report of the Durham food policy council*. Community Development Council Durham. Available from: https://www.durhamfoodpolicycouncil.com

Corbett, J. and Cochrane, L., 2017. Engaging with the participatory geoweb: experiential learning from practice. *In*: C.E.C. Campelo, M. Bertolotto, and P. Corcoran, eds. *Volunteered geographic information and the future of geospatial data*. Hershey: IGI Global, 1–18.

Devillers, R., *et al*., 2010. Thirty years of research on spatial data quality: achievements, failures, and opportunities. *Transactions in GIS*, 14 (4), 387–400. doi:10.1111/j.1467-9671.2010.01212.x

Elwood, S., 2009. Geographic information science: emerging research on the societal implications of the geospatial web. *Progress in Human Geography*, 34 (3), 349–357. doi:10.1177/0309132509340711

Elwood, S., Goodchild, M.F., and Sui, D.Z., 2012. Researching volunteered geographic information: spatial data, geographic research, and new social practice. *Annals of the Association of American Geographers*, 102 (3), 571–590. doi:10.1080/00045608.2011.595657

Fast, V. and Rinner, C., 2014. A systems perspective on volunteered geographic information. *ISPRS International Journal of Geo-Information*, 3 (4), 1278–1292. doi:10.3390/ijgi3041278

Fast, V. and Rinner, C., 2017. Mediating open data: providers, portals, and platforms. *Journal of the Urban and Regional Information Systems Association*, 28, 7–8.

Feagan, R., 2007. The place of food: mapping out the 'local' in local food systems. *Progress in Human Geography*, 31 (1), 23–42. doi:10.1177/0309132507073527

Goodchild, M.F., 2007. Citizens as sensors: the world of volunteered geography. *GeoJournal*, 69 (4), 211–221. doi:10.1007/s10708-007-9111-y

Haklay, M., 2014. Volunteered geographic information and citizen science. *In*: *Vespucci Summer Institute - VGI and citizen science: engaging, creating, and understanding*, Fiesole, Italy.

Haklay, M., 2013. Citizen science and volunteered geographic information: overview and typology of participation. *In*: D.Z. Sui, S. Elwood, and M.F. Goodchild, eds. *Crowdsourcing geographic knowledge: volunteered geographic information (VGI) in theory and practice*. Dordrecht: Springer, 105–122.

Hall, B., *et al*., 2010. Community-based production of geographic information using open source software and Web 2.0. *International Journal of Geographical Information Science*, 24 (5), 761–781. doi:10.1080/13658810903213288

Harper, A., *et al*. 2009. *Food policy councils: lessons learned. Institute for food and development policy*. Available from: http://www.farmlandinfo.org/sites/default/files/Food_Policy_Councils_1.pdf

Haworth, B., 2016. Emergency management perspectives on volunteered geographic information: opportunities, challenges and change. *Computers, Environment and Urban Systems*, 57, 189–198. doi:10.1016/j.compenvurbsys.2016.02.009

Helbich, M., *et al*., 2017. Food deserts? Healthy food access in Amsterdam. *Applied Geography*, 83, 1–12. doi:10.1016/j.apgeog.2017.02.015

Kearns, R., 2005. Knowing seeing? Undertaking observational research. *In*: I. Hay, ed. *Qualitative research methods in human geography*. 2nd ed. New York: Oxford University Press, 192–206.

Knapp, C.N. and Trainor, S.F., 2013. Adapting science to a warming world. *Global Environmental Change*, 23 (5), 1296–1306. doi:10.1016/j.gloenvcha.2013.07.007

Kretzmann, J.P. and McKnight, J.L., 1993. *Building communities from the inside out: a path toward finding and mobilizing a community's assets*. Evanston, IL: Institute for Policy Research, Northwestern University.

Lauriault, T.P. and Mooney, P., 2014. Crowdsourcing: a geographic approach to public engagement. *In*: *Internet Politics and Policy Conference, 2014*. Oxford: Oxford Internet Institute, The Programmable City Working Paper 6.

Lin, W., 2013. Volunteered geographic information and networked publics? Politics of everyday mapping and spatial narratives. *GeoJournal*, 78 (6), 949–965. doi:10.1007/s10708-013-9490-1

Nasr, J., *et al*., 2010. *Scaling up urban agriculture in Toronto* [online]. Building the Infrastructure, June. Toronto, ON: Metcalf. Available from: https://metcalffoundation.com/wp-content/uploads/2011/05/scaling-urban-agriculture.pdf

Neis, P. and Zielstra, D., 2014. Recent developments and future trends in volunteered geographic information research: the case of OpenStreetMap. *Future Internet*, 6 (1), 76–106. doi:10.3390/fi6010076

Neis, P. and Zipf, A., 2012. Analyzing the contributor activity of a volunteered geographic information project — the case of OpenStreetMap. *ISPRS International Journal of Geo-Information*, 1 (3), 146–165. doi:10.3390/ijgi1020146

Neptis Foundation. 2018. *Neptis Geoweb* [online]. Available from: http://www.neptisgeoweb.org [Accessed May 2018].

Neumann, W.P., Dixon, S.M., and Ekman, M., 2012. Ergonomics action research I: shifting from hypothesis testing to experiential learning. *Ergonomics*, 55 (10), 1127–1139. doi:10.1080/00140139.2012.700327

Okolloh, O., 2009. Ushahidi, or "testimony": Web 2.0 tools for crowdsourcing crisis information. *Participatory Learning and Action*, 59 (1), 65–70. Available from http://www.ingentaconnect.com/content/iiedpla/pla/2009/00000059/00000001/art00010.

Pothukuchi, K., *et al*., 2002. What's cooking in your food system? A guide to community food assessment. *In*: *Community food security coalition*, 127. Venice, CA: Community Food Security Coalition.

Durham Region Health Department. 2016. *Overview report: Health Neighbourhoods in Durham Region* [online]. Available from: https://www.durham.ca/en/health-and-wellness/resources/Documents/HealthInformationServices/HealthNeighbourhoods/overview_Report.pdf [Accessed May 2018].

Rinner, C. and Fast, V., 2015. A classification of user contributions on the participatory geoweb. *In*: F. Harvey and Y. Leung, eds. *Advances in spatial data handling and analysis: select papers from the 16th IGU Spatial Data Handling Symposium*. Switzerland: Springer, 35–49. doi:10.1007/978-3-319-19950-4

Robertson, C. and Feick, R., 2018. Inference and analysis across spatial supports in the big data era: uncertain point observations and geographic contexts. *Transactions in GIS*, 1–22. (May 2017). doi:10.1111/tgis.12321

Sani, A.P. and Rinner, C., 2011. A scalable geoweb tool for argumentation mapping. *Geomatica*, 65 (2), 145–156. doi:10.5623/cig2011-023

Schneider, G. and Fast, V., 2017. Mapping the growing capacity of climate smart food in urban environments. *Canadian Food Studies Journal*, 4 (2), 4–24. doi:10.15353/cfs-rcea.v4i2.242.

Sieber, R., 2006. Public participation geographic information systems: a literature review and framework. *Annals of the Association of American Geographers*, 96 (3), 491–507. doi:10.1111/j.1467-8306.2006.00702.x

Sieber, R.E., *et al*., 2016. Doing public participation on the geospatial web. *Annals of the Association of American Geographers*, 106 (5), 1030–1046. doi:10.1080/24694452.2016.1191325

Stefanidis, A., Crooks, A., and Radzikowski, J., 2011. Harvesting ambient geospatial information from social media feeds. *GeoJournal*, 78 (2), 319–338. doi:10.1007/s10708-011-9438-2

Sui, D.Z., Elwood, S., and Goodchild, M.F., 2013. *Crowdsourcing geographic knowledge: volunteered geographic information (VGI) in theory and practice* (D. Sui, S. Elwood, and M. Goodchild, eds.). Dordrecht: Springer Netherlands. doi:10.1007/978-94-007-4587-2.

Tomlinson, R., 2007. *Thinking about GIS: geographic information system planning for managers*. 3rd. Redlands: ESRI Press.

United Nations. 2013. *Wake up before it is too late: make agriculture truly sustainable now for food security in a changing climate* [online]. United Nations Trade and Environment Review, 341. ISSN:1810-5432. Available from: http://unctad.org/en/PublicationsLibrary/ditcted2012d3_en.pdf

Widener, M.J., *et al*., 2017. How do changes in the daily food and transportation environments affect grocery store accessibility? *Applied Geography*, 83, 46–62. doi:10.1016/j.apgeog.2017.03.018