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ARTICLES

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ABSTRACT

This article presents a methodological and technical reflection on an innovative and interactive qualitative geographic information systems (GIS) tool and method created to gauge people's images and perceptions of their neighbourhood. Knowledge gained from the critical GIS debates has led to the development of qualitative GIS and public participation GIS (PPGIS) methods, which aim to counteract the adverse effects of GIS as predominantly top-down. Drawing from critical and qualitative GIS arguments, the authors tried to create an accessible, bottom-up GIS data-collection method that involved conducting qualitative interviews while presenting digital maps on a tablet. This digital tool allowed users to change scales by zooming in and out on the map and also offered a selection of base maps affording numerous views of the city. This method not only allowed residents to generate GIS data about their neighbourhood but was also used as a visual support tool to stimulate dialogue during the interviews. With the aid of examples from a study in Geneva, Switzerland, this article discusses the relevance, strengths, and limitations of this method in the field of neighbourhood research.

Keywords: qualitative GIS, PPGIS, bottom-up GIS, critical GIS, mapping, interactive tablet, neighbourhoods, neighbourhood image, resident perspective

RÉSUMÉ

Cet article propose une réflexion méthodologique et technique sur un outil et une méthode de systèmes d'information géographique (SIG) qualitatifs qui se veulent interactifs et innovateurs. Ces derniers ont été élaborés dans l'idée d'explorer et évaluer les images et les perceptions que les résidents ont de leur quartier. Les critiques existant autour des méthodes utilisant les SIG, en particulier les effets défavorables liés à des approches des SIG qui sont avant tout descendants (top-down), se trouvent à l'origine de l'élaboration de SIG qualitatifs et de méthodes SIG basées sur la participation du public (SIGPP). Ainsi, en intégrant les arguments des débats autour des SIG qualitatifs, les auteurs ont eu l'ambition de créer une méthode accessible de collecte de données pour SIG ascendante (bottom-up). Celle-ci est caractérisée par la réalisation d'entretiens qualitatifs structurés autour d'une tablette électronique présentant des cartes numériques. Moyennant cet outil, les utilisateurs ont eu accès à de nombreuses vues cartographiques de la ville, notamment par l'utilisation du zoom qui a permis de varier les échelles, ainsi qu'en variant les fonds de carte. Cette méthode a non seulement permis aux résidents de générer des données SIG sur leur quartier, mais elle a également servi de support visuel stimulant le dialogue au cours des entretiens. A travers des exemples tirés d'une étude menée à Genève, en Suisse, cet article analyse la pertinence, les forces et les limites de cette méthode dans le domaine de la recherche sur les quartiers.

Mots clés : SIG qualitatif, SIGPP, SIG ascendant, SIG critique, cartographie, tablettes interactives, quartier, image de quartier, point de vue des résidents

Introduction

This paper presents a methodological and technical discussion of an innovative geographic information systems (GIS) data-collection method developed to enhance understanding of how residents make sense of urban space and spatially define their city's neighbourhoods. In a test phase of our research we observed that paper maps are a beneficial support tool during interviews for understanding residents' knowledge about the city; however, they lack certain interactive qualities which could be afforded through the use of digital maps. These interactive qualities, such as the ability to change scales through zooming in and out, are arguably one of the main benefits to using digital maps. Thus, we created an interactive mapping tool to gauge neighbourhood images from the perspective of

residents of Geneva, Switzerland, using a resident-generated GIS approach (Talen 1999). This innovative data-collection method consisted of thorough, qualitative semi-structured interviews in conjunction with the presentation of digital maps on a tablet (iPad® from Apple Inc.).[1] Using this interface, interviewees mapped their neighbourhood images and explained how they perceive and make sense of their city by simultaneously drawing on the tablet and talking with the interviewer. This combination of interview interactions (maps, drawing, and explaining) helped researchers gain a better understanding about residents' perceptions and knowledge of their city. Using this method and this particular mapping tool, we were able to gain deeper insight on residents' thoughts about their neighbourhood boundaries, attachment to place, knowledge about their community, and other general neighbourhood images, which could potentially lead to advancements in planning and urban development (Talen 1999).

We will start by briefly defining the notion of neighbourhood image and highlighting the questions that have guided our reflection. To make sense of urban space, residents refer to and orient themselves with their images of places, which translate to the knowledge they have about their city (Holloway and Hubbard 2000; Matei, Ball-Rokeach, and Qiu 2001). Neighbourhood image is the subjective perception of a place and encompasses the thoughts and knowledge that people have about different places in a city (Tani 2001). The notion of image is a dynamic and constantly evolving perception and piece of knowledge. It is partially subjective and collective, composed of various features and meanings associated to a place (Schoepfer, Zweifel, and Paisiou 2011). In our research, we investigate how images of the neighbourhood entity emerge and how they affect the way residents make sense of their city. In addition, we are interested in how images perform residents' choices, particularly in regard to the questions of residential type and location; how do images affect decisions for everyday practices of the city or for choosing residential locations? To help people understand neighbourhood images, various methods can be resourceful, each shedding light on different aspects of the research topic. Whereas quantitative methods such as surveys enable the evaluation of the types of neighbourhood images that residents have in regard to their lifestyles and socio-professional profiles (Permentier, Bolt, and van Ham 2011; Andersen 2008), qualitative approaches enable in-depth investigation about the meanings residents attribute to images by providing narratives about how images emerge and perform their decisions and the way they practise the city (Schoepfer, Zweifel, and Paisiou 2011). We sought to develop a particular methodology to obtain knowledge about how residents spatially define neighbourhoods by using maps as a visual support tool. Thus, we wanted to investigate questions such as how, why, and where do they locate neighbourhood boundaries, centre(s), and places that are meaningful for them? How do they form relationships between places? How do they compare and link certain neighbourhoods to others? What is the relevance and meaning of different geographical scales (e.g., whole city, administrative neighbourhoods, districts, housing blocks), and how can answers to those questions help us to better understand how residents make sense of, use, or practise their city?

To study subjective spatial knowledge and to gather perceptions and definitions that residents have about neighbourhoods units in their city, a range of qualitative methods using differing map types and various modes of mapping have been used. For example, mental-, cognitive-, or subjective-mapping (Lynch 1971; Gould and White 1974; Matei, Ball-Rokeach, and Qiu 2001; Downs and Stea 2005; den Besten 2010), alternative forms such as interactive spatial board games (Ramadier and Bronner 2006), and qualitative GIS (Aitken and Prosser 1990; Aitken and others 1993; Arias 1996; Aultman-Hall, Roorda, and Baetz 1997; Talen 2000; Talen and Shah 2007) have been employed along with qualitative interviews to enable interviewees to elaborate about maps using words. Our method was inspired by these examples that pioneered the integration of qualitative aspects into GIS data collection.

In the remaining sections of this paper, we first set the context of research on maps and mapping in neighbourhood studies and outline their three main qualities that prompted the use of qualitative GIS in neighbourhood image research. Second, we discuss and situate our research within the current state of the art of qualitative GIS before describing the tool and method we developed for the field. Then, in the results section, we provide insight about how our method enhances qualitative data collection and analysis while also discussing how the method benefits, affects, and performs the interview situation using examples from our fieldwork. Finally, we discuss the technological strengths and weaknesses of our method in regard to the mapping of neighbourhood images by residents.

Mapping neighbourhood images

In this section, we outline the main advantages of maps and mapping in the context of qualitative research on neighbourhoods and explain how three main qualities led to the development of a qualitative GIS-based tool and method. The first quality refers to the advantages of the spatial dimension of maps and the spatial potential of mapping. The second focuses on the ability to integrate participative and interactive aspects into mapping. Finally, the third represents the importance and strengths of qualitative research. Later in the discussion we draw on those three points, explaining how and why we incorporated them into our research.

Maps, as technical and cognitive images, have the potential to contain spatial information. They "help us make sense of the universe at different scales, from galaxies to

DNA, and connect the abstract with the concrete by overlaying meanings onto that world, from astrological deities to signatures for diseases. They help us remember what is important, and explore possible configurations of the unknown" (Okada, Buckingham Shum, and Sherborne 2008, vii). This quotation suggests that maps are thinking tools. They facilitate reflections about spatiality and scales, they help structure and eventually hierarchize information, and they also help create new ideas. In particular, the visual characteristics of maps, in the same way as other visual supports such as pictures or drawings (Margolis and Pauwels 2011), contribute greatly to the production of new knowledge in interview situations (Crang 2003; Rose 2007; Rose and Tolia-Kelly 2012). As Pavlovskaya states, "mapping previously unmapped phenomena [...] or theoretical relationships [...] makes these phenomena and relationships visible and, therefore, theoretically and politically significant. 'Positioning' them within GIS space, indeed, performs an ontological function; it creates the landscapes and worlds that embrace these processes" (Pavlovskaya 2006, 2016). Therefore, they can be seen as catalysts, or performative and powerful tools, which stimulate dialogue and reflection about issues that would be difficult to discuss without them. In addition, maps have a participative role in the interview, in the sense that the mapping process stimulates interaction between the interviewer and the interviewee (Talen 2000; Talen and Shah 2007). By "doing," interviewees become the "leaders" of the interview through participative knowledge building; this challenges power relations between the interviewees and the interviewer (Buckingham 2009).

The integration of the map as a visual and interactive device – in particular the mapping process – into a qualitative approach is important for addressing the embedded meanings that people give to space and the ways they define the spatial unit called neighbourhood. Drawings on the maps alone, without the possibility of giving explanation or telling stories to explain why and how interviewees make sense of them, would be difficult to understand. The dialogue enables an elicitation of the drawings and therefore an in-depth study of the questions of meaning that people attribute to them. Words have capacities that are different from the ones of visual support, and combining them is extremely beneficial to a fuller understanding of the precise questions of neighbourhood spatiality we outlined in the introduction, because of the high level of complexity associated with neighbourhoods, neighbourhood images. Therefore, we address questions linked to neighbourhood spatiality through the use of mapping in the context of qualitative questioning.

Researching spatial issues through maps and mapping also immediately raises questions concerning the critical cartography debate (Farinelli, Olsson, and Reichert 1994; Harley 1989, 2002; Crampton and Krygier 2005). From those raised in this vast debate, here we address only two essential critiques, which should be considered when working with qualitative mapping methods. We do not make the assumption that we have provided ready-made solutions for these critiques through our research, but rather, we acknowledge them in a reflective way. The first critique concerns the modes or the practices of how maps are produced: maps can be seen as the embodiment of power, not only because they legitimize certain realities while obscuring others (Harley 1989; Pickles 1995), but also because a certain technical knowledge is required to produce and to understand them. Therefore, maps can hold power; this fact is important to be aware of when using them in research. The second critique theoretically questions the map, which is understood as a visual representation; however, maps also contain their own cartographic language and require the reader to have a certain level of technical and spatial understanding before spatial information can be extracted. Castro (2011) outlines that (carto)graphic forms have a decisive impact on the ways of thinking by arguing that perception of the world and making sense of it are related to language types (e.g., cartographic). For instance, more-than-representational approaches (Rose 2003; Lorimer 2005; Thrift 2007) advise us to think beyond the actual image and to question what an image does (as an object) rather than what it is or represents, how it participates as a non-human actor in the generation of data (Crang 2003; Rose 2003).

Drawing on the inherent potential of maps when they are integrated in qualitative research, and acknowledging criticisms toward the use of maps in research about residents' sense-making of urban space, we developed a qualitative GIS method. Compared to other mapping methods, the qualitative GIS approach presents several advantages observable during data collection, processing, and analysis. In particular, this method is beneficial because it uses digital, interactive, multifunctional, and modifiable maps to integrate individual information during the interview. Moreover, the data are saved in the cloud, therefore directly available for analysis in the GIS environment, which enables facilitated processing for analysis. Our method, in contrast to the previous methods using qualitative GIS, is innovative because we used a customized set of feature classes on a familiar interface, which we present on an interactive tablet, allowing interviewees to draw directly and independently on the digital map to elucidate their neighbourhood perceptions and knowledge. In the next section, we discuss the origins and development of qualitative GIS in the field of neighbourhood studies, in particular by focusing on critical GIS debates.

Qualitative GIS

Qualitative GIS stems from the field of critical GIS, which developed in response to critiques that GIS focused too heavily on quantitative spatial analyses without concern

for the social implications of the technology (Schuurman 1999, 2000; Sheppard 2005). This resulted in numerous debates (for overviews see Harris and Weiner 1998; Schuurman 2000) between social theorists and geographers (Taylor 1990; Goodchild 1991; Openshaw 1991; Taylor and Overton 1991; Lake 1993) concerning the validity of this system, seen as top-down, positivist, and technicist (Aitken and Michel 1995; Talen 1999; Elwood 2006). Further critical GIS endeavours questioned and investigated the impacts of the use and production of technology rooted in positivism (Schuurman 1999; Chrisman 2005; Harvey, Kwan, and Pavlovskaya 2005), and others studied how power relations in society were embedded within GIS epistemologies (Harris and Weiner 1996; Sheppard 2005; Elwood 2006; Pavlovskaya 2006). These critiques drew attention to various weaknesses found within GIS and led to an examination of the validity and feasibility of the tools and methods used that subsequently opened the door for the conception of qualitative GIS applications (Harris and Weiner 1996; Talen 1999, 2000; Weiner, Harris, and Craig 2002). More specifically, non-cartographic varieties of spatial knowledge, such as photographs, transcripts, drawings, mental maps, and audio and video recordings, were integrated into GIS databases. Qualitative GIS methods have been used in political ecology (Heasley 2003; Jiang 2003; Robbins 2003), feminist geography (Rocheleau 1995; Kwan 2002; McLafferty 2002; Nightingale 2003), ethnographic research (Jiang 2003; Matthews, Detwiler, and Burton 2005), and urban change and neighbourhood studies (Talen 2000; Pavlovskaya 2002; Matthews, Detwiler, and Burton 2005; Talen and Shah 2007; Kwan and Ding 2008; Jung 2009; Jung and Elwood 2010). Many of the previously mentioned studies have incorporated public participation GIS (PPGIS) as a qualitative GIS method into their research. PPGIS methodologies were developed as a direct outcome of the social theoretical debates in GIS (Harris and Weiner 1996; Obermeyer 1998) as a solution to minimize adverse impacts of GIS in society (Harris and others 1995; Harris and Weiner 1996, 1998; Craig, Harris, and Weiner 2002). Since the 1990s, and corresponding with the critical GIS debate, there has been a shift in the GIS methods used in neighbourhood research studies, from a quantitative technology-based perspective to a more qualitative approach incorporating local knowledge of the general public into GIS in neighbourhood planning initiatives.

In neighbourhood studies, GIS was first used quantitatively as a data analysis platform to determine residents' familiarity and knowledge about their neighbourhood (Aitken and Prosser 1990), to operationalize this spatial familiarity (Aitken and others 1993), and to compare walking accessibility in neighbourhoods (Aultman-Hall, Roorda, and Baetz 1997). These methods were used for obtaining a better understanding of how residents viewed their neighbourhoods; however, qualitative GIS has a vast potential for growth in neighbourhood studies and can be developed to link neighbourhood variables such as environmental satisfaction, place attachment, and community liveability directly with GIS through resident-generated data-collection methods (Talen 1999). Talen (1999) was one of the first to discuss the importance of implementing qualitative principles into GIS to minimize various GIS critiques. Until the late 1990s, neighbourhood planning and research initiatives applied GIS methods from a quantitative perspective (Talen 1999) and in accordance with some critiques of GIS. Especially in neighbourhood research, the incorporation of the residents' knowledge about, perceptions of, and aspirations for their community should be considered when conducting research for the purposes of planning and development (Talen 1999). Talen (2000) and Talen and Shah (2007) conducted experiments for gauging neighbourhood perceptions through the use of qualitative GIS to produce knowledge through resident-generated bottom-up GIS methods using an interactive mapping interface on a laptop computer. This allowed multiple layers of information to be displayed and analysed for the basis of neighbourhood investigations (Talen 2000; Talen and Shah 2007). The high level of interactivity and the spatial benefits connected with GIS help to better facilitate the spatial patterns and behaviour by enabling researchers to view, interpret, and analyse the spatial relationships between people and their neighbourhoods. These recent studies have shown that GIS is an interesting and efficient platform to investigate neighbourhood characteristics and spatial relationships in a participative manner.

According to Talen (1999), PPGIS can be split into three broad categories. Two of them, those which have been most commonly applied, use traditional GIS data and methods. The first category focuses on empowerment of local community and neighbourhood groups by enabling access to GIS tools for mapping purposes (Craig and Elwood 1998; Elwood and Leitner 1998; Howard 1998; Kim 1998; Obermeyer 1998; Elwood and Ghose 2001; Leitner and others 2002). The second uses collaborative decision-making support systems through a range of visualization and communication methods available in GIS (Al-Kodmany 1998, 2001, 2002; Krygier 1999; Elwood and Ghose 2001; Jankowski and Nyerges 2001, 2003; Jordan 2002). The third category differs from traditional PPGIS methods as it focuses on generating bottom-up GIS data directly with residents to collect their local knowledge and perceptions and does not use traditional top-down GIS methods (Talen 1999; Talen 2000; Talen and Shah 2007). Adding local knowledge and perceptions to GIS allows further integration and investigation of the spatial complexity, spatial context, interactivity, and interconnection in neighbourhood research, while simultaneously minimizing adverse effects of ethical and epistemological critiques of GIS (Talen 2000; Talen and Shah 2007). The studies by Talen

(2000) and Talen and Shah (2007) revealed and captured neighbourhood preferences and socio-spatial environmental meaning into GIS data formats that enabled data and maps to be more subjective. The researchers used computers equipped with the GIS software ArcGIS, local base maps and data, and a person responsible for controlling the addition of data to the GIS via the computer (the GIS facilitator) to collect data at conferences (Talen 2000) and in public places (Talen and Shah 2007) by interviewing people about their neighbourhood perceptions. Results of these studies showed that the incorporation of resident knowledge into GIS improved understanding of residents' perceptions of neighbourhoods by showing how residents delineate neighbourhood boundaries, how they compare their home neighbourhood to others, and how they prescribe solutions for problems, such as traffic or noise (Talen 2000; Talen and Shah 2007).

Description of the tool and method

In this section we discuss the technical aspects of the creation of the tool and procedure for the interviews. We used the previously introduced theories of Talen (1999) as a basis of our research and built upon knowledge gained from Talen (2000) and Talen and Shah (2007) to create an accessible and intuitive GIS tool that maintains and improves the main strengths of bottom-up GIS and includes its interactive, participative, and spatially complex qualities.

To facilitate data collection using a tablet during interviews, a customized tool was created using the Environmental Systems Research Institute's (ESRI's) ArcMap Desktop 10.0, ArcServer, and the free ArcGIS application (app) for tablets and smartphones that enabled ease of access to data within the cloud (Bhat, Shah, and Ahmad 2011) – that is, data collected on the tablet was immediately available on ArcMap and ArcGIS online because of the cloud's data-sharing functionalities. This approach allows anyone with access to ArcGIS (including the ArcGIS server); a tablet, smartphone, or computer; and basic GIS knowledge to incorporate this tool into research through the use of the existing ArcGIS app. We created feature classes, which are used to store point, line, or polygon data in ArcGIS, and thematically organized into a feature data set (a group of feature classes) based on our research and interview questions (see Table 1 for list of feature classes and symbols).

Symbols were selected for each feature class, and subtypes were used with some feature classes to give the interviewee pre-defined options when adding their data to the map. The feature classes, and thus the feature data set, were published online using ArcServer, which allowed us to access the same feature classes from the ArcGIS app. The interviewees could draw on the map using these pre-defined feature classes. Within the app, tools for data collection, area and line measurements, base map selection, search, share, zoom in and out, and the option to create new, or select pre-defined, bookmarks (Figure 1) were available. We used the base map data provided in the ArcGIS app that consisted of 12 options; however, most interviewees preferred to use the base maps called Bing Maps Road, which labelled all streets; Imagery (satellite), which provided images without labels; and the OpenStreetMap, which gave detailed information about the transportation system. One may also open the legend to view the symbols and their meanings. During data collection, interviewees could add comments into the attribute table of the feature class (Figure 2a), draw points or polygons (Figure 2b, 2c), and view the attribute information for each (Figure 2d). Also, the date and time were recorded for each addition to the map to track the order of inputs and match them with the voice recording. Voice recordings were done for each interview, and notes were taken to keep track of observations about the reaction and behaviour of the interviewees in regard to the tool. After each interview the final map data (Figure 3 or 4) was downloaded from the server into a database and the map was cleared for the next interview.

A 20-minute introduction to the tool was given at the beginning of each interview in which a detailed description of all functionalities was provided, including how the interviewees could add their own inputs to the map using the pre-defined layers from the main menu with the aid of a stylus pen. During the interview, questions were grouped into categories based on our broad research questions (see Table 1 for sample questions). To start the interview, we asked the interviewees to locate their previous residences on the map and to describe their residential experiences in the city. Then, to gain knowledge about the spatial definition of neighbourhoods, we asked interviewees to define different areas of the city including their home neighbourhood and areas they considered good or bad, as well as the area in which they would look for an apartment – in other words, where they could imagine living. They were asked to delineate different zones by drawing on the digital map using the polygon tool (Figure 3 or 4) while at the same time verbally explaining to the interviewer the main characteristics and positive or negative aspects of the neighbourhood, or, in other words, the perceptions and meanings they attributed to boundaries. Interviewees were also asked to locate frequented places and to discuss other places that have meaning for them. They also defined places they were afraid to go as well as places they often hear about in the news. Lastly, the interviewer and the interviewee examined the map together using the view of the whole city while the interviewee discussed his or her general impression of the tool and the learning process which took place during the interview.

Table 1. Question blocks, sample questions, feature classes, and subset symbology*

Question block	Sample questions	Feature classes	Subset symbology
Evaluation of neighbourhood/ residential choices	Can you show neighbourhoods on the map that are good/bad and describe why you would/ would not want to live there?	Point	Good
			Bad
			Other
		Polygon	Good
			Bad
			Other
Neighbourhood characteristics	Can you describe the characteristics of your home neighbourhood?	Point	Landmark
			Park
			Transport
	Can you describe the characteristics of the neighbourhood in which you would ideally like to live?		Other
			School
			Bar/restaurant
			Grocery store
	Can you describe the characteristics of the neighbourhood in which you would never like to live?		Centre of neighbourhood
			People
			Event
			Fear place
	Can you show on the map places that cause you to be afraid or unsafe?	Polygon	Fear space
Neighbourhood boundaries	Where do you draw the borders of your neighbourhood on the map?	Polygon	Frontier/boundary
Media knowledge	Which areas are talked about in the media? What crimes are happening?	Polygon	Media
Role of image in residential choice	To what extent did the way you see your neighbourhood play an important role in your residential choice?	Polygon	Residential choice

* This table shows the general question blocks which represent the broad categories of questions that we wanted to ask about neighbourhood characteristics, including the evaluation of neighbourhoods, the characteristics, boundaries, knowledge produced by the media, and the role of neighbourhood image in residential choice. The table also shows samples of questions asked during the interview, the types of features we used to represent the possible answers to the questions, and the symbologies that were used to represent the options for each feature.

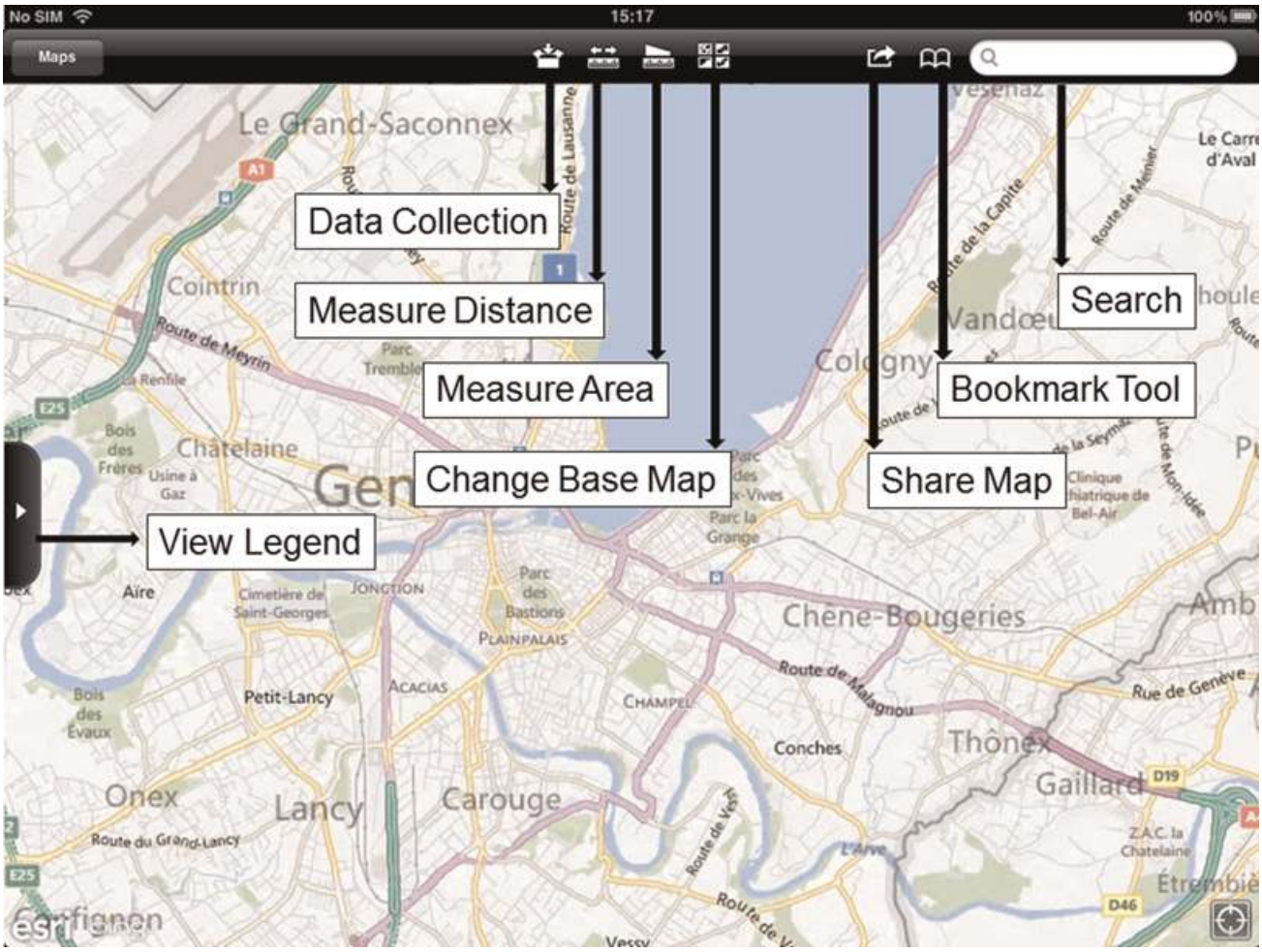

Figure 1. This figure displays the interface which was used in interview situations. It is a direct screenshot of the iPad interface displaying the ArcGIS app and the base map of Geneva. Here, the symbols have been labelled to denote the meaning of each one. The symbols represent the tools to collect data, to measure line and area distances, to change the base map, to share the map, the use the bookmark (which allows the user to revert to the zoomed-out view of the city), and to search. The View Legend arrow allows the user to open the legend to view the meanings of the additions they have already drawn on the map.

In total, each interview lasted between 1 hour and 30 minutes and 1 hour and 50 minutes, including the time spent on the introduction of the tool.

Results from a case study

In this section, we provide examples of results from a case study to illustrate how we could gain knowledge about neighbourhood images through the use of our method and tool. By integrating the spatial dimensions of maps and mapping, the interactivity of the mapping tool, and the significance of qualitative research, we were able to investigate our research questions about the spatial definition of neighbourhood image from the perspective of residents and, more generally, to understand spatial practices and sense-making in an urban context. The fieldwork consisted of 16 in-depth interviews with young professionals (aged 25–40) with higher education and living in Geneva, Switzerland. More specifically, we aimed at interviewing socially and economically active people living in, or close to, the city centre, who frequent the many amenities (shops, bars, restaurants, etc.) in those areas.

To gain knowledge about the spatial definition of neighbourhoods, we asked interviewees to define different areas by drawing on the map. These drawings were facilitated through the zoom tools that enabled the interviewee to attain the appropriate scale. By observing how the interviewees shaped these zones using the polygon tool, including how they drew angles and the precise vertices of the shape while explaining their thoughts, we were able

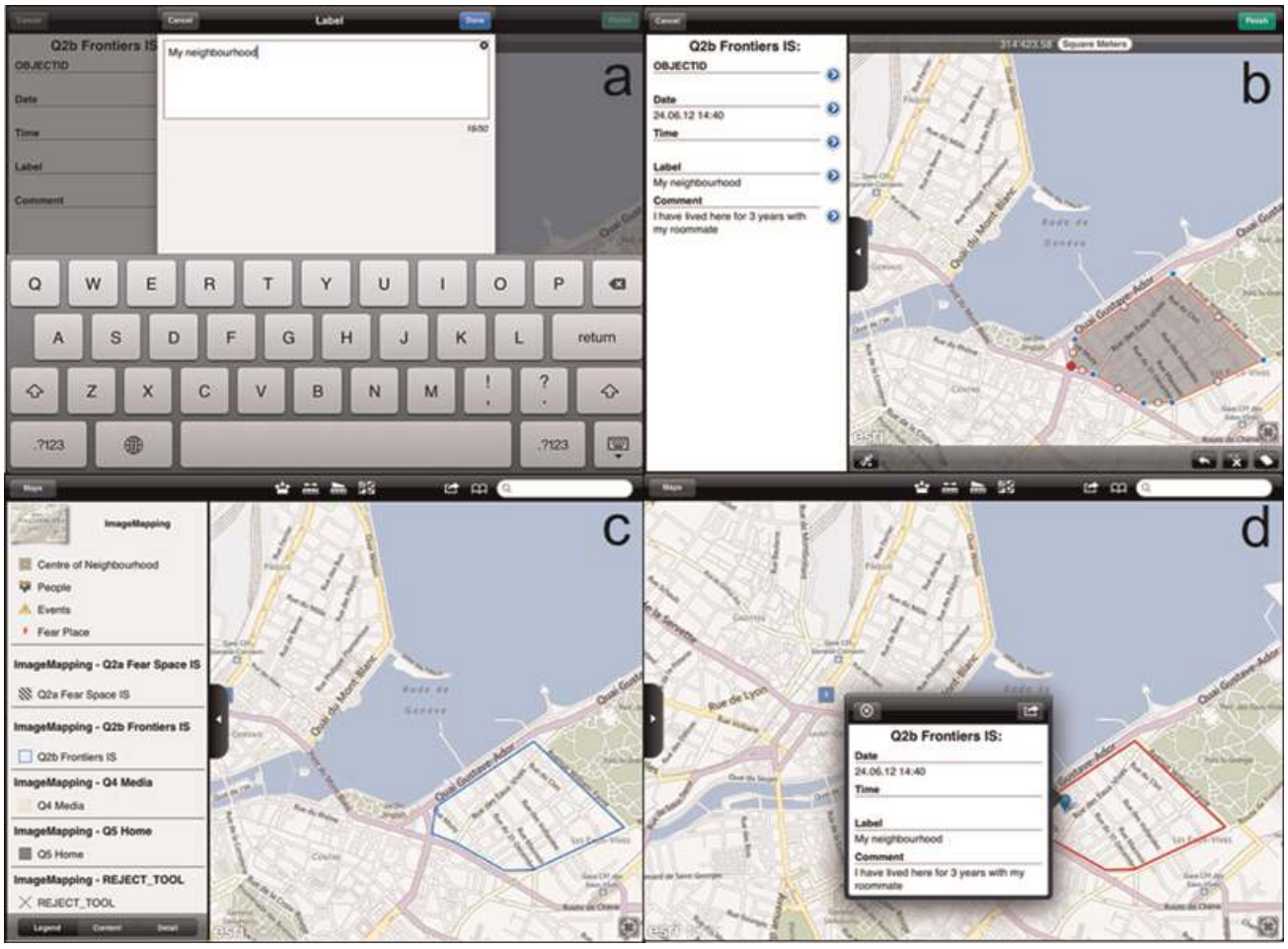

Figure 2. This figure shows the process of adding a polygon to the map. When the polygon tool is selected, the user has the ability to enter information such as the date, time, label, and comments into the attribute table (a). After the polygon has been drawn and the attributes have been entered, the user presses the "Finish" button, which is located in the top right-hand corner of the screen (b). Afterward, the new polygon can be seen on the map (c). When the polygon has been selected on the map, a pop-up shows the attributes for that particular polygon (d).

to gain information about neighbourhood boundaries. For example, if the interviewee had a high level of knowledge about the city, precise delineations were often drawn based on reference points. Those points referred to collective spatial knowledge such as roads, street names, the beginning of a park, bus stops, official buildings (e.g., schools or recreation centres), as well as to more personal references, like where their car was parked or the houses of friends. The digital map on the tablet enabled them to manually search, by moving the map, zooming in and out, to find specific places they were looking for. The search tool was also helpful to more quickly locate a precise address they were looking for. In cases where the interviewee lacked knowledge about a particular area, the delineations became less precise and more emphasis was placed on verbal explanations rather than on detailed additions to the map. In this case, some explained that the built space did not have a specificity that was significant enough for them. In particular, an interviewee explained that it was difficult to set a precise limit between her home neighbourhood and the adjacent one because the architecture was the same. This specific example also highlights how important the dialogue was for the interviewee to explain the drawings, and in this case it gave the interviewer the chance to understand why drawing a precise limit was difficult in some instances.

The usefulness of the polygon tool combined with the interaction between the interviewee and the researcher could also be seen in the following example, when an interviewee explained, "The street 'Rue de la Servette' is included in my neighbourhood because the grocery store I go to is there, and it goes until here [...] this is the tobacconist where I buy cigarettes – but I'll stop smoking on Monday – then I place a limit point here, because in this courtyard we are having happy hour very often, and

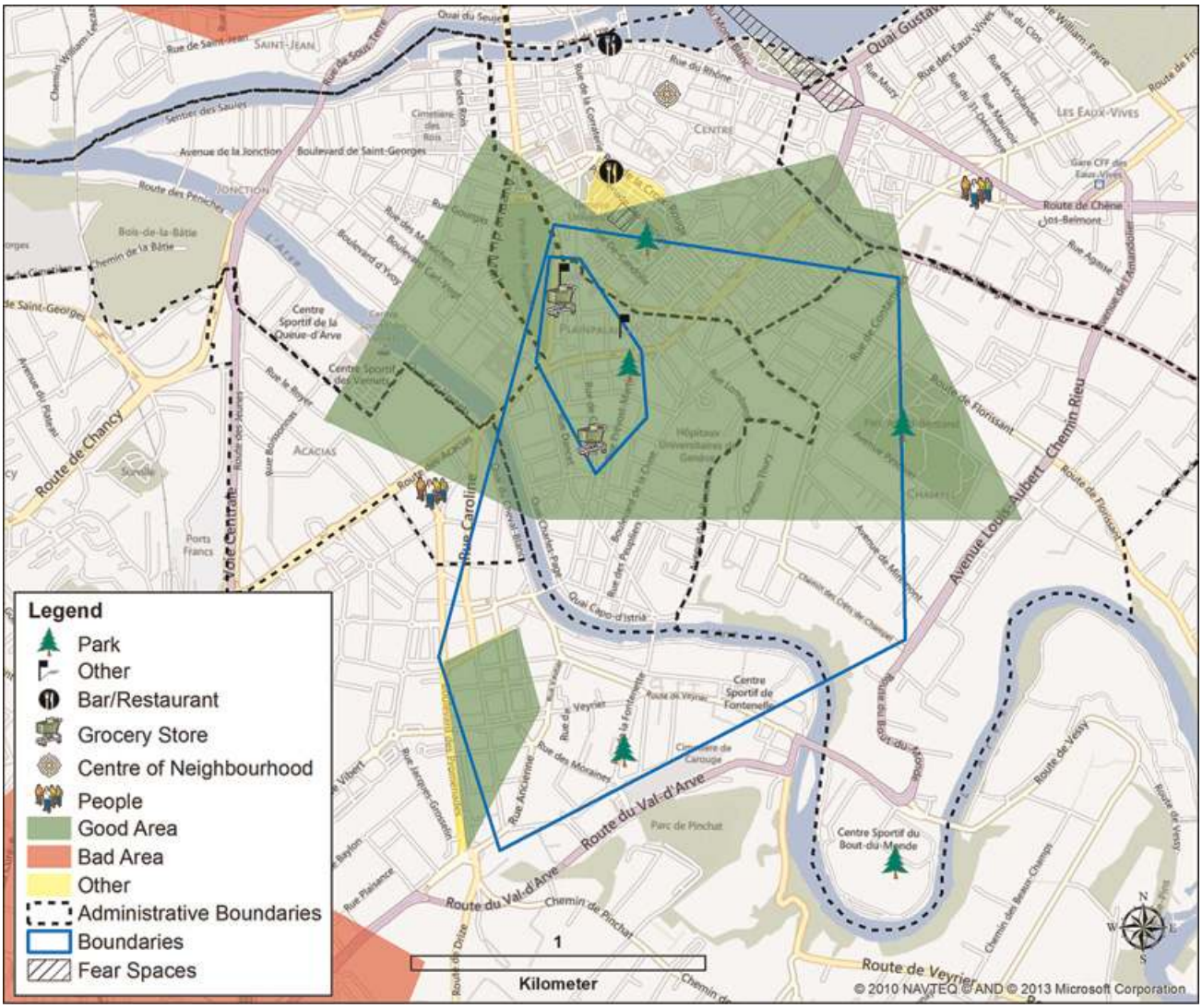

Figure 3. This figure shows an example of results obtained from an interview. Particularly, this displays how residents' perceived neighbourhood boundaries are often different than administrative boundaries. The small blue polygon represents the interviewee's "home" neighbourhood, the larger blue polygon represents the location where the interviewee would search for an apartment, and the dashed black lines represent the neighbourhood administrative boundaries.

here because it is a Turkish restaurant where they make very good food. Here I am not sure; there is nothing, so I just draw a straight line. Then the train station is the limit on this side. All the clusters of houses belonging to Les Schtroumpfs, as well as Îlot 13 are included." The example highlights how interviewees discussed each vertex of the polygon they drew; therefore this process prompted them to reflect about their perception of neighbourhood limits and how each limit made sense for them. Throughout the interview, the interviewees often spontaneously explained why they drew the limits where they did, and sometimes they were asked to elaborate. Thus, when defining neighbourhoods, the combination of drawing with the polygon tool and explaining was efficient because interviewees were able to explain how they made sense of particular areas. Hence, one interviewee explained that her home neighbourhood, which she named by its official name, corresponds to her everyday-life space, which was delimited by a park and the house of a neighbourhood association and centred on her children's school. By comparing her drawn area with the administrative neighbourhood boundaries of Geneva, we noticed that she defined "her" neighbourhood much smaller than the administrative limits (Figure 3). If she had only spoken about the limits without drawing them on the map, we would not have been able to realize this size difference. So the tool enhanced communication between the researcher and the interviewee and enabled discussion about the overall definition of neighbourhood and, specifically, how it has different meanings for different people.

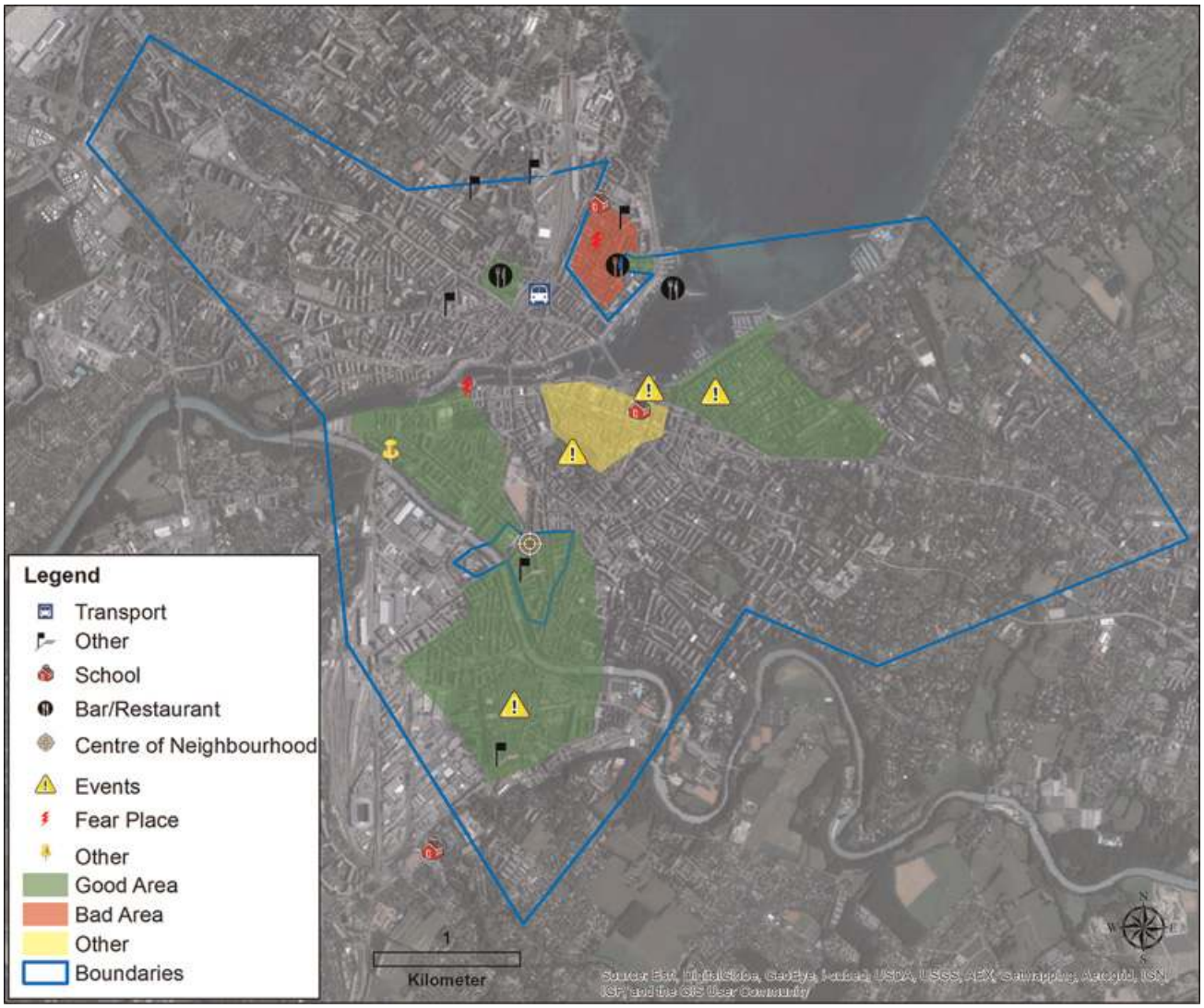

Figure 4. This figure shows another example of the results from an interview displayed on the satellite imagery base map. The option to change base maps allowed the interviewee to obtain different perspectives of the city.

When interviewees wanted to emphasize a piece of information related to a certain drawing, they could add comments directly into the dialogue box, thus the attribute table for the feature class (Figure 2a). Interviewees said they found this option useful to insist upon a point and to remember their argument later in the interview by consulting it. For example, interviewees could add attribute information to distinguish between several polygons drawn with the same tool to differentiate between them. Moreover, this recorded information helped to structure, and thus simplify, the analysis of the data.

While defining zones, interviewees also often changed the base map on the tool. Some interviewees used a combination of maps (i.e., the street map, the detailed transportation map, or the satellite image) to have a different perspective on the city (Figure 4). They explained that they could gather distinctive types of information from one map or the other and that this was helpful for orientation purposes so that they could become more precise when drawing their additions on the map. In particular, the satellite map was used by those interviewees who had a high level of knowledge about the city, and only to define their home neighbourhood. One interviewee said, "I like the satellite map a lot because I recognize the courtyards and the trees, and it helps to get oriented. It's more like a picture." Likewise, interviewees who often used public transportation found the transportation map more helpful for orientation purposes.

To learn about how residents gained knowledge about the city through their residential locations, we asked interviewees to draw and explain where they have previously lived and their current residential location in the city while discussing why they chose to move from one place to another (in fact, all of the interviewees moved several

times in the city of Geneva). We could then relate that knowledge with other elements they drew on the map, such as the areas they defined as good or bad. Thus, we observed that neighbourhoods they lived in were generally in or close to zones evaluated as good areas on the map. Some interviewees mentioned that the map stimulated their memory and enabled them to trace their residential lives in greater detail. This exercise also enabled us to observe the temporal dimension of sense-making of a city, which is the acquisition of knowledge over time.

While adding different points and polygons on their personalized map, interviewees could form relationships between distinct zones. That is, they could see where points and polygons were overlapping, therefore allowing them to encounter spatial relationships that were not previously considered. For example, as shown in Figure 3, the interviewee defined the zone where she would look for an apartment (bigger blue outline) inside of the area that she defined as her home neighbourhood (smaller blue outline) and partially overlapping with the area defined as a "good neighbourhood" (green polygon). The personalized map became more complex as the interview progressed and new elements were added based on the already existing ones. The addition of new elements was facilitated through the vectorial property of the features, meaning that the drawings remained proportional to the scale of the map. While drawing new elements and giving more information, interviewees could thoroughly explain the relationships between the elements on the map. For example, one interviewee clarified that he drew red polygons representing the places he would never live, but each had different meanings to him. One was drawn for security reasons and the other because he thought that area was boring "because residents are older, and are always complaining because of the noise." Moreover, the personalized map facilitated discussion about how and why they practise or get around the city and which types of transportation they use. In fact, maps inspired interviewees to speak about mobility because they gave them the ability to link the different places they had drawn to the type of transportation they used to get from one place to another. For example, when interviewees talked about places where they felt insecure, they used the map to show which path they would take to avoid certain areas even if it meant taking a longer trip home. Some interviewees also explained how they got to know a place by passing it while on the bus or by working in the area. Therefore, the process of constructing a personalized map during the interview revealed different aspects about neighbourhood images. From this process, we could also learn that neighbourhood images are constantly renegotiated and altered. In fact, some interviewees explained their discomfort about "fixing" information on a map because they felt that it would make their enunciation definitive, whereas they explained that their opinions are often changing according to different situations. For example, an interviewee mentioned some places where she currently likes to go out, but those were related to her recent experiences, and if the interview had been a month before, her opinions would have been different.

The sentences "the map gives me ideas" and "the map made me realize that" were used often throughout the interviews. When interviewees talked about good residential neighbourhoods, they often discovered other "good areas" by using the zooming tool and thinking about exactly how they should draw the zone limits on the map. Sometimes while talking about their drawings, the interviewees altered their zones because they renegotiated them throughout the discussion. For example, one modified the extents of a zone, while others added more "good areas" to the ones they had already drawn and discussed at the beginning of the interview. Thus, the map enabled an extensive discussion about the map additions. The interactive quality of the method also enabled moments where the interviewer could ask questions such as "what do you think about your personalized map of the city? Do you recognize your personal way of moving around the city on it? Would you add something else that is important to you?" – while also provoking direct reactions from the interviewee by making hypotheses such as "when I look at your personalized map, I would say that you are doing most of your activities in your home neighbourhood, is this correct?" In one particular example, the interviewee wanted to add some more important social places situated in another neighbourhood of the city, which he forgot to mention previously. We also had the chance to elaborate with hypothetical scenarios such as this: "and if you would move to another neighbourhood, which places would you continue to go to?" So with the maps produced by the interviewees, we obtained an idea about how residents experience the city through their daily practices, routines, and actions and how these have an important impact on the constitution of neighbourhood images.

Discussion

In this section we discuss three categories of arguments that are important to understand the benefits and limitations of the qualitative GIS approach we chose for our research. First, we look at the methodological issues raised in the paper under the three qualities of maps in qualitative research, namely the spatial dimensions of maps and mapping, the interactivity of the mapping tool, and the significance of qualitative research. Then, returning to the critical GIS debates, we address some ethical issues that we wanted to tackle, which allows reflection from an epistemological level. Finally, on a more practical level we consider the technical questions which arose while discussing the enhancements and limitations of the tool and method more generally.

INTEGRATION OF MAPPING, VISUALIZATION, AND QUALITATIVE ASPECTS INTO OUR TOOL

Maps are considered spatial tools because they show an orthogonal, or bird's-eye, view of the world that enables a reflection about where things are located in space and in relation to each other. Identifying boundaries is defined by Talen (2000) and Talen and Shah (2007) as being one of the most beneficial uses of GIS in neighbourhood studies. In fact, the use of our method on the tablet allowed new boundaries to be discovered. As we saw through examples in the results section, the integration of digital maps presented on a tablet in the interview situation allowed the interviewee to refer to the maps to show the researchers places they were talking about, to locate and delimit places, and to evaluate these connections and the distances between them. We could observe that while the interviewees were drawing, they found patterns in their data that they had never considered before. Typically, as each interview proceeded, more meaningful places were "discovered" by the interviewees, enabling the interviewee to continually generate comparisons and relationships between and among elements that were drawn in regard to the different spatial units (the neighbourhoods). This result was directly attributable to the enhanced spatial complexity and connectivity associated with GIS on a tablet. As we have shown through the results, the digital and interactive map is a sophisticated spatial tool that offers great advantages in comparison to a paper map. The zoom tool enabled interviewees to consider the map at different scales, and they had the flexibility to move the map around to view a specific location or to directly investigate a place using keywords with the search tool. The option of changing the base map while maintaining their personal additions to the map enabled various views and perspectives of the city. Also, the polygon tool required the interviewee to think precisely about area boundaries, since it uses points to shape the zones, which forces a more precise attention to detail compared to the freehand drawing with a pen on a paper map. One particularly striking aspect was that the interviewees enjoyed playing around on the tablet because they felt at ease with it and they found the tool entertaining. Therefore, they said they enjoyed the interviews and that the method made complete sense to them.

The interviewees referred to the map while explaining their perceptions and knowledge about places. As we showed in an example in the result section, interviewees could discuss their residential life at the same time they used the point tool to denote their previous and current residences in the city. The arguments about mapping and interaction through visualization enabled us to consider the tool as a data generator or a catalyst for discussion. The personalized map, along with discussion with the interviewer, allowed residents to establish, visualize, and understand new spatial relationships (point densities, proximities, distances, and general distributions in the city). For example, when interviewees narrated their residential lives while zooming and drawing on the map, they could make concrete relationships between their residential life and knowledge of the city. This relational thinking was noticeably facilitated through the interactive qualities of the map presented on a tablet as we mentioned above. In the same way, the interactive map acted as a thinking tool, because interviewees learned to create a personalized map and take something away from the experience.

THE INCORPORATION OF CRITICAL GIS DEBATES

One of the main motivating factors for using resident-generated bottom-up GIS is that it allows residents, as opposed to technical experts, to create GIS data and facilitates neighbourhood interaction by exposing the inner cognitive views of a neighbourhood in a highly visual, dynamic, place-specific format. This factor promotes neighbourhood participation and involvement for future planning processes (Talen 1999, 2000; Talen and Shah 2007). In the studies conducted by Talen (2000) and Talen and Shah (2007), a GIS facilitator was required to sit with the interviewees during the interview and introduce them to GIS data. The facilitator was also in control of the inputs to GIS by translating the ideas of the interviewees into point, line, and polygon forms, thus into common GIS data formats. Because of this methodology, the participants were not directly accessing and creating the knowledge on their own, but rather were creating it through the interpretations of the GIS facilitator. As claimed by authors using other visual methods in social science, the integration of a visual material into the interview situation causes power to be redistributed between the interviewer and interviewee (Rose 2007; Buckingham 2009). Our study allowed interviewees to create GIS data themselves by inputting their knowledge and perceptions about neighbourhoods directly onto the intuitive mapping interface using a stylus pen and the technical aid of the interviewee, if needed. They had full control of the tool; they could zoom in and out, use the search function, decide which map layers to display, and add new items to the map. So they enhanced their skills and gained knowledge about their neighbourhood and city. These benefits of the tool as a learning process contribute to making it original. From an ethical level, it was important for us to try to tackle the issue of power relations in our interview situations. Allowing residents to create GIS data themselves counteracted the top-down, positivist, and technicist (Aitken and Michel 1995) aspects of GIS.

Some authors contributing to the critical cartography debate point out that maps (Castro 2011) and technology (Hesse-Biber 2011) have their own languages that are not understandable by everyone. Thus, when designing our tool we took these critiques into consideration to make the interface as intuitive as possible to lessen issues with

maps and mapping technology. In particular, we used an interface that all of our interviewees were familiar with, as each had a tablet or smartphone. With our interactive and intuitive interface, we also showed that the method was easy to learn, understand, and use; thus no previous GIS knowledge was required. The interviewees quickly gained technical knowledge required to manipulate the tool and record their neighbourhood perceptions and knowledge into GIS formats. This method demonstrates that GIS does not have to be seen as technicist when used in this manner and actually has the potential to be more democratic than originally thought by those who criticized it. Nevertheless, this argument has to be qualified, because it is dependent on the target group. We did our interviews in Geneva, with young active professionals, who all already had some knowledge about technology. In our case, this pre-knowledge was an advantage, but conversely it could also be a disadvantage to those unfamiliar with this technology. In addition, the case study in which we used the method was particularly appropriate for this method, in regard to the topic, the context, and the target group. Although not all of our interviewees had the same comfort level with the tool, the method enabled us to address these issues in two ways: first, because the map drawings were verbally linked to explanations about the places mentioned, and second, because the interviewer was able to help with any technical issues that arose. Therefore, when a certain characteristic on the map was difficult to define, the interviewees would orally explain their thoughts in more detail.

GIS maps, data, and knowledge are often produced in a positivistic and power-related manner, thus legitimizing certain realities while obscuring others (Pickles 1995). Often government-generated GIS data (such as census information, land parcel boundaries, neighbourhood delineations, location of amenities, etc.) do not take into account the social implications of knowledge production and often include class, gender, and race hierarchies (Pavlovskaya 2002), as well as introducing bias into qualitative data-collection methods, as recognized by Talen (2000). To attempt to minimize this bias, we did not use pre-existing GIS data layers but only road maps (with street names) and satellite imagery (no labels). We understand that the base maps we used were pre-existing, but without overlaying GIS information such as government-generated neighbourhood boundaries, we attempted to lessen some of the effects of this bias.

TECHNICAL ENHANCEMENTS AND LIMITATIONS

Drawing from our fieldwork experiences with the tool and the method, we outline here their benefits and strengths regarding tool development, data collection, and analysis. As Talen (2000) and Talen and Shah (2007) experienced, the time-consuming process of base data collection can be prohibitive; however, because we used a customized version of the ArcGIS app as our main tool, the infrastructure and base data were already available. The creation and publication of feature classes to the server required some previous GIS knowledge and took a couple of days to initiate, but GIS skills were not required to operate the tool. So we avoided the time-consuming process of training and using GIS facilitators, which Talen (2000) and Talen and Shah (2007) described as a time constraint. Instead, the interviewees operated the tool themselves after a short introduction. This method is beneficial not only from the aspect of time but also from a methodological perspective, giving the interviewee control of the tool to draw and add features to the map by themselves.

Data collection and analysis were also enhanced by sharing GIS data in the cloud. The collected data could be directly analysed without the need for data entry or preprocessing steps, such as the digitization of results, which increased data reliability. In addition, data access in the cloud allowed us to use a tablet for data collection instead of a desktop or laptop computer as used in previous research (Talen 2000 and Talen and Shah 2007). In GIS format, layers from different interviews can be overlaid and analysed for spatial analysis. Also, because the time was recorded during data creation, we could analyse the features step by step and also correspond voice recording of the interviewee with mapping.

We chose to use a tablet because of its portability, intuitiveness, and easy-going aspects that people were familiar with. In regard to its portability, we experienced that working with a mobile device such as a tablet is practical because it is light and compact and therefore easy to carry around. The intuitiveness significantly improved the fieldwork process, and interviewees expressed that they felt at ease and were not intimidated by the tool. The interface was easy to use in terms of its intuitive symbologies, such as the shopping cart denoting a grocery store or a tree to define a park (see Table 1 for more examples). In addition, the main menu consisted of a minimal number of options so the user was not overwhelmed. A main strength of the tool in regard to paper maps, for instance, was the vectorial property of the features. Not only could the interviewees zoom in and out and move the map as they wanted, but as the map moved, the features remained proportional. This action allowed the interviewees to have new perspectives, both literally from a visual point of view and figuratively from the point of view of creating new ideas, which arise from these new perspectives on the personalized map. The fact that the interviewee could freely draw, and also erase, provided them with confidence because they could not make an irrevocable mistake. Although this tool was beneficial to this study, we would like to point out that it may not be useful for all types of fieldwork or groups of people, as those who are less familiar with this type of technology might not be able to use the tool as effectively as our study group.

One drawback of our tool is that an Internet connection from either a wireless or mobile network was needed to collect data, which corresponds to limitations in the existing ArcGIS app interface. Theoretically, data can also be collected offline but this requires further steps in the development of the tool. Another point to be discussed is the use of a polygon tool versus the freehand drawing tool. Some interviewees found it difficult to draw the polygons and talk at the same time because they needed to concentrate. In the future, we suggest the implementation of the option to use a freehand drawing tool, which might make drawing easier but, as outlined before, the interviewee would not be forced to think very precisely about how they draw the shape. A good alternative could be to offer both possibilities, which we were not able to do at this stage as the freehand tool is not yet available on the ArcGIS app.

The ease of development and use of this tool was made possible through the growing applications of the Geographic World Wide Web (geoweb) and Web 2.0, which link together geographic locations and information from the Internet (Haklay, Singleton, and Parker 2008) to form a "Neogeography" (Turner 2006). The development of simple user interfaces and mobile services allows individuals and communities to access GIS, cartographic, and Internet capabilities without the need for professional training (Elwood 2011). As a result, we had the capability to gather information about neighbourhoods using an interactive tool. Regarding accessibility of our tool, an ArcGIS licence is required for the initial creation and publication of customized feature classes to the server, which poses a potential problem to those without access to these products, as ArcGIS licences with server functionality can cost thousands of dollars to establish and maintain. But a licence is not required to access data from the app or online, which enables data sharing from multiple platforms in common GIS formats after the initial setup of the tool. From the perspectives of hardware and software, the method could technically be used on any computer with ArcGIS, on any smartphone or tablet with the ArcGIS app installed, or from the ArcGIS online Web site (http://www.arcgis.com/features), linked by an ESRI Global Account. With the current state and expected developments of free and open-source software (FOSS) GIS capabilities, as well as the growing application of the geoweb, a great possibility exists to create the same tool and procedures using free software and servers in the future (http://www.osgeo.org) (Elwood 2010).

Conclusion

This article presented a methodological and technical reflection about an innovative and interactive qualitative GIS method set up for gauging neighbourhood perceptions and spatial definitions from the perspective of residents. This method, and in particular the use of a GIS interface on a tablet, was developed to give residents a voice in data collection, which developed in reaction to the ethical and epistemological critiques of GIS. We wanted to allow interviewees to have the freedom to create their own GIS data while simultaneously being engaged in a learning process and enhancing their technological skills. The interviewees also had the opportunity to be reflective about what neighbourhoods mean to them and whether certain scales are more appropriate according to the situation (e.g., in regard to feeling "at home" or the importance of social connections with neighbours). Knowledge gained from our study contributes to thematic findings in neighbourhood studies concerning questions such as how people imagine and make sense of urban space, as well as increasing knowledge about the integration of technical and methodological aspects into tool development. As we showed in the discussion, the development of the method raised three levels of questions. On a methodological level, using mapping, visualization, and qualitative interview techniques, we showed how knowledge could be generated on the topic of neighbourhood characteristics including attachment to place, knowledge about communities, and general neighbourhood images while using an auto-reflective, intuitive, and interactive application on a tablet. We showed how we stimulated dialogue on the topic of neighbourhoods by displaying their interconnectivity and spatiality, enabling interviewees to see their environments with a new perspective. By using a method that combines the three aspects of mapping, visualization, and verbal interaction, we were able to acquire a better understanding about the neighbourhood perceptions of residents because feelings cannot always be portrayed on a map, and conversely, spatial relationships cannot always be easily explained through words. The complementarity of both visual and verbal information was highly beneficial.

Then, on an epistemological level, we tackled some ethical questions raised through critical GIS debates. In particular, we wanted to develop a method that allowed the interviewee to use the tool independently, and therefore it had to be intuitive and easy to use. In the case of our interviewee group, namely persons who were familiar with the technology and with the reading of maps, this aim seemed to be reached. Nonetheless, this aspect has to be questioned according to the target group, because the method could be less relevant for some studies implicating interviewees who would not feel at ease with tablets or with maps. Another point is that we wanted the interviews to be a beneficial exchange for both the researchers and the interviewees. We wanted them to be able to learn something from it, and on this perspective we received encouraging feedback: our interviewees said not only that they enjoyed learning about the technique, but also that they enjoyed having the chance to think differently about their everyday life through the use of the interactive map.

Finally, on a practical level, the elaboration of the method enabled us to address some technical issues. In particular, we developed a mapping tool that allowed us to tackle the challenges of paper maps, both in the data collection and in the data analysis. In particular, the zooming tool and the vectorial properties of the drawings were advantageous for discussing scale issues and stimulated interactivity. More generally, because of the accessibility of the tool, we believe that other researchers could easily adapt it to their own studies.

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Note

1 The fieldwork consisted of 16 in-depth interviews in Geneva, Switzerland. The goal was to interview socially and economically active young people who regularly frequent the many amenities (shops, bars, restaurants, etc.) in the city centre.

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