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COMBINING GIS WITH QUALITATIVE METHODS IN URBAN RESEARCH

Abstract

The rise of Big Data, much of which contains spatial information, such as geotagged social media or GPS-tracked movements has provoked discussions about the salience of geospatial knowledge for how we understand and govern cities. This paper argues that attempts to make sense of "data avalanche" could benefit from taking a closer look at the critical arguments and practices of qualitative GIS research. Qualitative GIS (QGIS) emerged at the beginning of 2000s as a way to problematize the dominance of quantitative methods in geography and the power-laden nature of new technologies. Using the examples of QGIS application in urban studies literature, this paper discusses methodological and theoretical implications of different strategies to gather and analyze data (from simple geocoding to building customized applications). It explores how QGIS may give qualitative data a spatial dimension, open up opportunities for public participation and make the invisible visible, allowing to discover new patterns and therefore serving as a heuristic tool for research. This paper contributes to the ongoing discussion about the transformations of geographical knowledge by putting current debates into historical context. Learning from previous QGIS practices may also serve as a source of inspiration for future studies, allowing to shed new light upon relatively well-researched topics such as gender and the city, social exclusion, mobility or urban memories.

Keywords: qualitative GIS (QGIS), participatory GIS (PGIS), urban studies, mapping, geographical knowledge.

Introduction

The rise of Big Data, much of which contains spatial information (such as geotagged social media or GPS-tracked movements) has provoked discussions about the salience of geospatial knowledge for how we understand and govern cities (Shelton 2016; Leszczynski 2016; Barnes and Wilson 2014). The proponents of Big Data talk about the emergence of "data-driven geography" and the fourth paradigm of scientific discovery driven not by theory but data (Miller and Goodchild 2014). Meanwhile, the critics of Big Data argue that it promotes a universal and essentialized understanding of a city that oversights the differences, depoliticizes injustices and relies solely on quantitative methods which it considers a higher form of knowledge (Shelton 2016; Graham and Shelton 2013).

These disagreements are in many ways not new. They resonate with the earlier debates about the dominance of quantitative methods in social sciences and geography in particular (described by Massey in 1999 as "physics envy"[1]), and discussions caused by the rapid growth of GIS (geographic information systems) in the 1970s–1980s. One of the responses against quantification of geographic research and as a way to problematize power-laden nature of new technologies and its effect on society was the development of qualitative GIS (QGIS) at the beginning of 2000s. At first, it was regarded by many scholars both from GIS and human geography as an oxymoron: since the term GIS had been coined four decades earlier, it had been strongly associated solely with quantitative methods and positivist approach (Kwan and Knigge 2006; Sheppard 2005[2]). Since then, however, a more qualitative nature of GIS has been fruitfully explored across various disciplines, from health research to history.

The word "qualitative" may relate to the form of evidence (e.g., in-depth interviews that contain rich descriptive data and personal interpretations, researcher's observations and field notes, photographs, audio and video clips,

[1] In fact, the discussion on qualitative and quantitative methods and methodologies in geography goes even further back, at least starting from the Hartshorne-Schaefer debate of the 1950s which marked the beginning of "quantitative revolution" that was harshly criticized two decades later (Graham and Shelton 2013). While the quantitative-qualitative divide will be mentioned throughout this paper, the detailed examination is out of its scope.

[2] See examples of quantitative methods and applications in GIS: Wang, F. *Quantitative Methods and Socio-Economic Applications in GIS* (Second Edition). CRC Press, 2014.

sketched maps and other drawings) as well as to data analysis, for instance when such techniques as grounded theory or discourse analysis are used (Cope and Elwood 2009). But are qualitative data and methods at all compatible with GIS? Pavlovskaya (2006:12) puts forward an intriguing, even if somewhat contradictory argument that "the most widely used functions in GIS, such as visualization, database development, management, and querying, are not at all quantitative despite that the dominant narratives construct GIS as a quantitative analytical tool." Even though integrating qualitative and GIS elements faces a number of challenges, as will be discussed in the last section, there is a plethora of examples when it leads to compelling and robust research.

While the most significant theoretical advancements in QGIS were arguably made in the mid-2000s, the above-mentioned attempts to make sense of "data avalanche" and resist total quantification of geographic research could benefit from taking a closer look at the critical arguments made by QGIS proponents and their practices. As Pavlovskaya (2017:10) put it, "learning about contributions of qualitative GIS would prepare scholars in social sciences and humanities for the challenges of big data and the digital age."

In order to assist this learning, the subsequent sections examine theoretical roots of qualitative GIS and compare arguments of critical GIS community with ones from opponents of Big Data; then, using specific examples, they discuss affordances and limitations of qualitative GIS.

On Theoretical Roots

This chapter will not go into the detail about the history of qualitative GIS, as these accounts can be found elsewhere (Cope and Elwood 2009). However, to understand the main principles, methods and research interests of QGIS, it is necessary to at least briefly describe a theoretical background it emerged from.

To start with, qualitative GIS did not appear in isolation. It can be regarded as a vivid example of mixing qualitative and quantitative methods which, together with the so-called "spatial turn" in social sciences (as well as in physical sciences and humanities) and emergence of new means of understanding, creating and acquiring spatial data constitute "'geography's turn to synthesis and holism" in the first decade of the 21st century (DeLyser and Sui 2014). This turn aimed to overcome divisions between human and physical geography, nature, and society, both qualitative and quantitative (DeLyser and Sui 2014). These

"hybrid geographies" in a way embodied a conviction that "geographers are well positioned to combine technical practice, quantitative methods and critical scholarship" (Graham and Shelton 2013).

Nevertheless, it does not imply there were no tensions along these division lines. As already mentioned in the introduction, the rapid growth of geographic information systems (GIS) caused a stir between GIS scientists who saw GIS as a new way towards integrated scientific geography and human geographers who took this technological development with a big pinch of salt. They problematized the production of spatial knowledge and questioned the neutral nature of GIS technology, pointing out that GIS was initially developed for the military and not for ordinary people, and that it continues to serve the interests of corporate and governmental powers[3]. They emphasized how the classifications adopted in GIS analysis of census data may shape society and expressed early concerns about the digital divide, arguing that uneven access among social actors to GIS would potentially enhance existing social and geographical inequalities. Another point of their criticism was that GIS software, reflecting its origins in cartography, represents space in a Cartesian coordinate system, or, in other words, as a set of attributes attached to places rather than interdependencies between them. Therefore, it is not suitable to deal with non-European conceptions of space and other ways of knowing (Sheppard 2005; Elwood 2009; Pavlovskaya 2012).

The proponents of GIS condemned this critique as too simplistic, paranoid and "indicating a lack of understanding of and experience with GIS or a lack of patience or aptitude for the rigors of science" (Sheppard 2005). In fact, from 1983 and until the meeting at Friday Harbor (USA) in 1993 there was little communication between the critical and the GIS "cultures" within geography. That meeting, initiated by the National Center for Geospatial Intelligence Standards

[3] One of the earliest and most controversial publications about the political and power-laden nature of technology was the *Ground Truth* by Pickles published in 1995. The consideration of the inner politics of GIS, with a particular focus to its participatory dimension and criticism of proprietary software has been further developed in a plethora of publications (see Sarah Elwood 2006; Ghose and Welcenbach 2018). These concerns are paralleled by the growing recognition of the implications arising from the discrepancies between technical and local knowledge. For instance, when local groups are unable to translate their experiences into codified hydrological knowledge, they are not considered as relevant actors and are therefore excluded from the decision-making process surrounding water allocation and distribution (see more on this: Usón, Henríquez, and Dame 2017; Budds 2009).

(NGGIS), challenged this intellectual divide by gathering GIS specialists and social theorists to initiate a more constructive engagement. While this meeting did not resolve all the disagreements, it marked a shift in the debates towards a dialogue and played a key role in developing the "GIS and Society" research agenda (Sheppard 2005).

Over time the "GIS and Society" agenda expanded to what Nadine Schuurman labeled in 1999[4] as "critical GIS" research (see more on this development: Sheppard 2005; Harvey, Kwan, and Pavlovskaya 2005). Qualitative GIS, together with public participation GIS (PPGIS) and feminist GIS were among the commonly defined and mutually connected subfields of critical GIS. Feminist geographers, such as Kwan, Cope, Elwood, Leszczynski and Schuurman, made key contributions to the development of critical GIS in general and its qualitative strand in particular, producing critique of scientific "objectivity" and problematizing the production of knowledge (Harvey, Kwan and Pavlovskaya 2005; Bergmann et al 2016). Feminist geographers hold that qualitative methods would enable researchers to address a wide array of non-quantifiable aspects that are ignored (and thereby marginalized) by mainstream geography based solely on quantitative data. Such aspects may include informal social practices and alternative economies, unpaid domestic work and all sorts of oppression and exploitation, as well as emotions and local knowledge (Pavlovskaya 2017). According to proponents of QGIS, qualitative methods provide room for integrating multiple forms of data and creating "a bigger picture and greater insight into what is happening (and why)" (Bagheri 2014).

From GIS and Society to Big Data

Discussions within the critical GIS community in some important ways resemble concerns regarding Big Data raised several decades later. First of all, both GIS and Big Data have been framed by their proponents in geography as a way to increase the relevance of the discipline, to gain "unprecedented insights" and to produce "fundamentally new ways of knowing, enacting, and being in the world" (Shelton et al 2014). For their critics, both technological developments pose a risk to crowd out or delegitimize other — critical, qualitative and

[4] Schuurman, Nadine. Lessons in Constructing a Science: Promises and Pitfalls of GIS. Paper read at *Geographic Information and Society* in 1999, Minneapolis, MN.

postpositivist — ways of knowing and research (Elwood 2009; Graham and Shelton 2013).

Secondly, similar to critical GIS scholars, opponents of Big Data argue that it may reinforce existing inequalities: "because data are always constructed, collected, stored, and used under uneven and variegated social, economic, and technical contexts, some people, places, and processes will always be easier to enroll into such vast sociotechnical assemblages" (Graham and Shelton 2013). This sociospatial unevenness of representation in online datasets has material effects — in other words, it is more than a reflection of the world but has a substantial power to shape it (see Shelton 2016 for a detailed discussion of this).

The third similarity is linked to the previous one: technology is not neutral, despite an air of objectivity that surrounds quantitative methods. Data do not speak for themselves, and the way we collect and analyze them is inevitably loaded with certain assumptions about the world. What is more, and this is rather a new feature that pertains to Big Data, the enormous size of datasets, reliance on proprietary software and blackboxed algorithms (e.g., of filtering, aggregation, etc.) lead to the increased uncertainty of data and the risk of losing sight of the very things such data represent (Kwan 2016; Shelton 2016).

The Power of Visualization

As demonstrated throughout this chapter, qualitative research may deploy GIS in various ways. But, arguably, the most important function of GIS is visualization – a term which encompasses a wide range of methods that provide insight into data through visual representations (Knigge and Cope 2006). Visualization makes the invisible visible (Kwan 2015) and provides opportunities for heuristic understanding of data and processes. That maps always represent partial knowledge, reflecting and constructing power relations is perhaps familiar for everyone interested in critical approaches to cartography (see, for example, Wood 2003). This is how Pavlovskaya (2017:2) puts it, explaining the power of visualization: "once visible, the mapped places and phenomena become real; they exist and require explanation… omission from the map, either intentional or by ignorance, in contrast, leads to theoretical as well as socioeconomic and cultural marginalization." Therefore, critical visualization should involve asking whose interests are missing or ignored in the planning process (Kwan 2015).

Therefore, it is no wonder that qualitative GIS has been extensively applied by scholars seeking to advocate for social justice and give voice to the people that are usually neglected in the city planning process — not only ethnic minorities or the poor, but also children (e.g. Alarasi, Martinez, and Amer 2015) and the elderly (Meijering and Weitkamp 2016; Milton et al 2015). However, the invisible not always equals the oppressed: a good example is a study on artistic communities and creative industries in Darwin, Australia; with the help of ethnography and GIS it demonstrated that most creative activity takes places outside formal cultural hubs — this insight might be useful for local policy-makers (Brennan-Horley and Gibson 2009).

Participatory GIS (PGIS) and public participation GIS (PPGIS)[5] have greatly contributed to the development of QGIS. Numerous PGIS/PPGIS projects aim to translate local spatial knowledge into claims on resources and land, attempting to secure community access to them by mapping informal land-use rights or, for instance, collective use of fishing grounds (Ghose 2009; Pavlovskaya 2017). While some consider PGIS/PPGIS an important tool contributing to "renegotiations of colonial legacies in many parts of the world, advancing and also posing challenges to postcolonial struggle" (Pavlovskaya 2017), Radil and Anderson (2016) have recently argued that PPGIS lost its political potential. According to them, as PPGIS works within established frameworks of institutionalized governance to produce a politics of consensus[6], it is ill-equipped

[5] The underlying idea of both PPGIS and PGIS is to support "the inclusion and empowerment of individuals and communities that have not been traditionally involved in urban or rural planning" (Brown and Kyttä 2014). While some differences between them are distinguished (e.g. PPGIS is more used in relation to developed countries and PGIS in the developing world; PGIS often uses purposive sampling to include key stakeholders into the mapping process while PPGIS mostly involves probability sampling (Brown and Kyttä 2014), they are often used interchangeably by some researchers (Pascual et al, 2016; Elwood 2008). Here they will be referred together as PGIS/PPGIS.

[6] A similar criticism of consensus was expressed by Purcell (2009) in relation to the "communicative turn" in urban planning. His key argument is that by seeking to resolve any conflict and neutralize power relations, consensus provides an attractive way for neoliberals to maintain their hegemony. Approaching the issue of participation from another angle, it is useful to recall a paper by Baud (2016) which examines, based on case studies in India, South Africa, Brazil, and Peru, whether using GIS and participatory processes in local governance increase the potential for building adaptive capacity and inclusivity. One of the main results is that "codified and technical knowledge remain dominant in discussions on urban development" (similar

to challenge the conditions of socio-economic inequality it strives to ameliorate (and in fact often reproduces them).

Addressing informality often implies contrasting fieldwork data with official, "objective" knowledge, such as statistics or administrative boundaries. Examining these discrepancies is not confined to PPGIS but may be found in political and cultural geography. A good example is a study by Pain et al (2006) which discovered that crime hotspots often do not reflect residents' experiences of crime. Their study used a combination of GIS mapping of crime hotspots[7] and lighting coverage with a subsequent rapid qualitative appraisal of residents' perceptions. Important to note, the qualitative stage was separate from the GIS: it was decided not to use maps with local residents[8] in order to avoid creating a certain impression of the areas or influencing the answers. Qualitative part not only revealed discrepancies from official police data (e.g. some types of crime were underreported) but, most crucially, allowed to better understand complex relations between crime, fear and lighting: crime was perceived by residents as committed largely by insiders and underpinned by economic and social deprivation, which means that a technical fix — just improving the lightning — without larger socioeconomic changes might have little effect in the areas.

Qualitative GIS not only allows visualizing data but also gives it a spatial dimension. For example, Hannah and Hodder (2015) use GIS to research how the unequally contested meanings and narratives of slavery and emancipation are reproduced through commemorative landscapes of Fredericksburg, Virginia. In another example (Keddem et al 2015) GIS helped to analyze and spatially represent the influence and intensity of neighborhood characteristics (vacant properties, illegal dumping, parks, tree canopy, aggravated assaults and theft) on asthma in West Philadelphia. In a nutshell, a combination of GIS and qualitative methods can bring fruitful results not only for geography, but also, as these cases show, offer a new angle on historical and health research.

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argument but in a different context was expressed in footnote 3).These arguments are given not in order to undermine PPGIS/PGIS projects but to provoke a fruitful discussion on how to overcome the current challenges and limitations.

7 Hotspot mapping identifies concentrations in the spatial distribution of point features, for example, crime locations. It is a valuable tool which, however, is also subject to interpretative issues: the maps will look quite different depending on the threshold used to define a hotspot (Pain et al 2006).

8 Therefore, the researchers insist that this is not a public participation GIS.

QGIS as a Part of Mixed Methods

This section takes a closer look at the methodology and explores the main strategies of combining GIS and qualitative research. QGIS is typically considered as pertaining to mixed-methods approach. This approach, Elwood and Cope (2014) argue, plays an important role in geography, where many questions require investigating interrelated human and physical processes and examining relationships at different scales. This research often consists of multiple phases which enable a "layered appreciation of experiences" and has a potential to provide a more comprehensive, nuanced and contextualized understanding (Bell et al 2015). According to Preston and Wilson (2014), multi-channeled and iterative nature of QGIS allows for more inclusive data collection and production of different forms of knowledge. The focus is, therefore, less on a product — a map — but rather on the process of research into a spatial problem.

In mixed methods research GIS-based analysis may be deployed to complement, triangulate (verify results using more than one data sources) or, as mentioned above, to contrast the knowledge acquired from different sources (Kwan and Ding 2008; Pfeffer et al 2011). For instance, in one of the pioneering QGIS studies (2002) Pavlovskaya complemented the ethnographic data with GIS maps to illuminate the multiple economies in post-Soviet Moscow at the household level. Another example is the research on mobility among the elderly (Meijering and Weitkamp 2016) where the results obtained from tracking mobility devices were integrated and compared with self-reported travel diaries. It opened up new research questions and enriched a grasp of the complexity of everyday geographies.

Obtaining Qualitative and Spatial Data

In mixed methods data can be obtained in both sequential and convergent ways. Sometimes the process starts with a participatory mapping exercise (e.g. mental mapping in Palermo, see Alaimo and Picone 2015; or putting stickers on printed Google Earth images to identify and describe locations in a study of children's perception of the city center, see Alarasi et al 2015). Information

on mobility can be obtained, as was noted above, from GPS-receivers and/or self-reported travel diaries.

A further discussion of results is important: it gives an opportunity for a truly in-depth understanding and may yield crucial clarifications, helping to avoid misinterpretations (Bell et al, 2015). It can happen in a form of a group discussion when participants co-construct a story with the researcher by engaging in the analysis and interpretation of the maps they produced or provided data for. Another option for discussion and getting a deeper understanding is a guided tour the route of which is mainly predetermined on the previously mapped locations (Alarasi et al, 2015).

An interview is, perhaps, the most popular instrument for obtaining information that complements quantitative data from surveys and institutional databases. However, often it is not a traditional interview, which has been criticized for "being unable to understand "lived experiences" of place", but an emplaced go-along interview, when participants walk the researcher through the places of interest. Asking questions is complemented by observations, allowing the researcher to examine the informant's practices and interpretations (Bell et al 2015). It can also take a form of a map-based interview, when maps serve as a visual aid to discuss participant's practices, inviting them to explain why particular places where chosen (Alarasi et al, 2015; Bell et al, 2015). Some studies employ multiple (or even all) of these strategies to collect data.

Analyzing Data: From Grounded Theory to Software Programming

Cope and Elwood (2009) describe three main approaches to combine qualitative research and GIS: 1) modifying qualitative data, usually with help of coding, to represent them using cartographic techniques such as classification and symbolization; 2) hyperlinking, which associates qualitative data with spatial objects in GIS; 3) software modifications that extend capabilities of conventional GIS. Yet, an overview of the recent studies using QGIS reveals that hyperlinking is often closely associated with coding or another approach of linking spatial and qualitative databases within GIS, but is seldom described as a separate strategy. Therefore, this subsection will elaborate on a slightly different set of approaches.

Coding

Mapping data from in-depth interviews was the first attempt to ingrate GIS into qualitative research (Jung and Elwood 2010). Interview transcriptions were analyzed using coding techniques adopted from grounded theory (Strauss and Corbin 1998) and then put on a map in a GIS application. Some CAQDAS (Computer Assisted/Aided Qualitative Data Analysis) packages, such as Atlas.ti or NVivo, have a function of geocoding data (see a detailed description of using Atlast.ti for a research in urban sociology: Verd and Porcel 2012). The "grounded visualization" approach was suggested by Knigge and Cope (2006) to further integrate qualitative analysis with spatial visualization. According to them, visualization and grounded theory work well together and share a number of important features: they both involve multiple rounds of data collection and analysis accompanied by critical reflection, which allows for more exploratory and robust inductive research rather than "hypothesis testing"; simultaneous attention is paid to different scales, to the particular and the general, the concrete and the abstract; they can accommodate and represent multiple worldviews and interpretations (Knigge and Cope, 2006).

While coding various types of qualitative data is the most accessible way to bring together GIS and qualitative research, it is also the most limited (Jung and Elwood 2010; Lafreniere and Gilliland 2015): data remain ***outside*** the GIS and, therefore, their in-depth exploration and analysis cannot be performed within GIS (Hannah and Hodder 2015).

Creating Databases

As Jung and Elwood (2010) note, researchers have taken two strategies to overcome these limits. One of them is to link a spatial database of a GIS to a separate database containing the qualitative data. For example, Hannah and Hodder (2015) describe how they worked with geodatabases in ArcGIS and organized attribute tables in a way that allowed to code "each marker, measure its visitability, and perform content and discourse analysis on markers selected by their locations or by certain attributes." In her study on Iranian women's sociospatial behaviors in Tehran's modern and traditional public spaces Bagheri (2014) also thoroughly explains how she used databases in ArcGIS. Before that, however, during the ethnographic stage of her research Bagheri created spatial

behavior maps of the selected spaces to track women's numbers and activities, indicating their approximate age, the style of their hijab and makeup, whether they were alone or in a group. She also drew architectural sketches to "capture a sense of place" and conducted semi-structured interviews with women about their feelings, experience and preferences in using those public spaces. Then she digitized her maps, created a database storing interview locations, counts of women and men in those spaces and interviewee's characteristics (such as age, education, and home location), as well as her field notes. With the help of Overlay function in ArcGIS, she examined the relationship between different official demographic/socioeconomic data layers and databases she created. The use of database allowed her to link interesting spatial patterns to interviewee's characteristics.

Programming Software

The second option to bring qualitative data directly into a GIS application is programming qualitative analysis functions in ArcGIS software. In the famous geo-narrative analysis performed by Kwan and Ding (2008) an extension called the "'space-time coder" was developed to code emotions, spatial and temporal references from narrative materials (oral histories, life histories and biographies) and analyze them within ArcGIS.

This research has inspired other scholars to visualize human mobilities and enhance understanding of everyday practices. Even though such routine practices seem mundane and remarkable, Bell et al (2015) argue they could have important implications through repetition over time, "both for our own wellbeing and that of the environment."

It is worth noticing that time represents an important category for research on human mobility and constructing personalized geo-narratives. These narratives, as Kwan and Ding (2008) note, are not static. One of Kwan's studies examined "a geography of fear" experienced by a Muslim woman during her daily travels around the city before and after 9/11 (Kwan, 2008). Kwan identified certain temporal patterns in the chronology of the informant's experience and how they evolved differently among different participants. In her previous contribution to time-space geography Kwan (2002) used information from women's diaries to analyze gender differences in access to urban opportunities. Her three-dimensional visualizations revealed how gender, class and race continue to shape the use of urban space.

Additional Strategies: Contextualizing Data and Digitizing Mental Maps

One of the important tasks for qualitative GIS has been to map locations that do not have absolute Euclidian geometries and are expressed solely by situational relationships, such as the "new mill near where the river bends" (Lafreniere and Gilliland, 2015). Techniques to visualize these qualitative locations have been developed by Jung and Elwood (2010) and some other scholars. Recently, a valuable contribution to the qualitative understanding of space was made by Lafreniere and Gilliland (2015) in their historical GIS study (HGIS) of London. They suggest that a wide range of qualitative and quantitative data (e.g. maps, texts, social surveys or photographs) should be used to establish "spatial clues" and provide rich contextualization for the mapped locations to go "beyond merely putting one layer of space-time data atop another, or placing the paths against a backdrop such as Google Earth."

As one of the underlying assumptions of QGIS is that multiple ways of knowing are possible, it allows representing a city from the non-standard point of view — that of its citizens. Alaimo and Picone (2015) push the boundaries of traditional representation by merging mental maps produced by residents of one neighborhood in Palermo into a single map in GIS. This is how they describe their approach: "If most mental maps of a neighborhood would stretch the role of the central market square, we have tried to emphasize that role by enlarging the dimensions of the square, even in contrast with the scale ratio." In a similar vein, neighborhood boundaries were highlighted according to citizens' perception instead of the administrative limits imposed by the municipality.

The examples above provide an illustration of how various qualitative methods can be combined with the GIS in different ways, depending on the research goals and questions. They can be applied separately, as in the study by Pain et al, or simultaneously, as in the research by Bagheri: in the first round of analysis she noticed some unexpected segregation patterns, which informed new questions for the subsequent interviews. In other words, there is no one size fit all solution. What these two different studies demonstrate is that the qualitative part was helpful in explaining things that could hardly be addressed by quantitative methods alone, but also how quantitative methods provide a good point to embark on qualitative research. As noted by Bagheri, she understood in her study how both qualitative and quantitative characteristics of

public spaces influenced women's behavior, and therefore qualitative-quantitative dichotomy seemed inadequate in understanding the complex relationship. There are, however, a number of limitations, some of which will be discussed in the next section.

Limitations, Challenges and Further Research

While just a decade ago geospatial analysis was confined to professionals familiar with desktop GIS packages, today numerous applications are freely available both for individual and collective maps production (Lafreniere and Gilliland 2015; Pavlovskaya 2017). This production is also facilitated by the increase in municipal data that is/can be georeferenced and is largely motivated by an awareness of the importance of geography to understanding social issues (Shelton 2016). What can be problematic about these positive tendencies? According to Shelton (2016), a potential pitfall is to create another "simplistic map mashup visualization." These visualizations and questions that drive them tend to treat social and spatial processes in isolation and thereby decontextualize them. This is how he puts it: "… in simply focusing on mapping the locations and concentrations of x or y urban problem, these visualizations fail to attend to how these problems, and certainly any meaningful solution for them, goes beyond a set of latitude and longitude coordinates or a particular bounded spatial unit like a census tract or municipal boundary." An example he gives is the case of mapping platforms of vacant and abandoned properties in Louisville, Kentucky, which help to construct a geographical imaginary of this problem as being in many ways synonymous with the city's predominantly poor and African-American West End, but do not address the root causes of these problems.

This observation does not explicitly relate to critical qualitative GIS practices due to its characteristics outlined in the previous sections. But I think it is still useful to remind that just making a map about social problems or even gathering qualitative data is not enough. It is necessary to move from simple counting to actual analysis, to address the roots of the problem and pay attention to the context. This, however, is not an easy undertaking. One may face a number of practical and theoretical challenges; some of them are outlined further below.

Data exclusion and data scale incompatibility are two important limitations outlined by Bagheri (2014). Although quite common, they are rarely addressed

in the literature. Generally speaking, the process of mapping always implies the inclusion of one thing and exclusion of other. Bagheri questions the claim made by some scholars that qualitative methods allow mapping almost any type of data, arguing that the way in which it can be done will not necessarily be inclusive, efficient and meaningful. She points out that transferring rich and complex qualitative data into quantitative GIS codes and symbols remain challenging, and the potential data exclusion in this transformation process is an inevitable disadvantage of GIS (see also Jung and Elwood 2010). Reflecting on her need to summarize, choose and often exclude data from each interview according to what seemed more or less relevant for her as a researcher, Bagheri concludes that "GIS is not an independent tool; rather, it becomes part of the storytelling itself."

While linking pre-existing datasets (acquired, for instance, from censuses) to the dataset created with help of qualitative techniques is widely used in QGIS, the issue of scale incompatibility is seldom discussed. Using the example of her case study, Bagheri argues that analytical linking qualitative data (e.g., from participant observations and interviews, based on individuals' opinions) to quantitative data layers in GIS (based on social and/or demographic data gathered and normalized at either neighborhood, district or city level) may be difficult and sometimes impossible considering their different scales. The risk is to draw wrong conclusions, leading in this case "to a wrong correlation between women's hijab and the quantitative attributes of the district where the interviews were conducted." In short, overlapping of data should be approached with caution: depending on the questions asked, this capability of QGIS can bring insights or misguide the researcher. Somewhat similar concern was brought by Pain et al (2016): different layers of data are not always mutually reinforcing, and dealing with these discrepancies require great caution and triangulation efforts — in sum, qualitative and participatory elements usually cannot be simply and easily added to GIS analysis.

Another limitation, quite trivial but still important, especially in the case of public participation GIS projects, is that "technology is not foolproof" (Bell et al 2015). In their study of urban green space they had three accelerometers and one GPS unit broken, resulting in data loss and participant disappointment. Also, in case of PPGIS projects, the result heavily depends on cooperation and patience of the participants (multiple phase studies tend to be time-consuming not only for the researchers but also their informants). For instance, as one researcher involved in a qualitative GIS project told in private communication,

while participation was voluntary and the study was quite short-termed, a number of participants did not follow the basic instructions.

Finally, although qualitative GIS offers more breadth, depth and flexibility (Preston and Wilson 2014) comparing to the quantitative approach, including certain types of information remains unresolved. For instance, some ethnographic data, such as feelings, a rationale for including certain locations or the impact of their symbolic meaning on informant's behavior, still cannot be mapped in GIS (Bagheri 2014). Another difficulty, which is particularly relevant for urban research, is dealing with verticality, at least in two-dimensional cartographic representations. Cities are increasingly segregated by height, writes Stephen Graham (2016) in his recent book *Vertical: The City from Satellites to Bunkers*. He demonstrates how verticality becomes increasingly more important category that determines inequality, politics and identity. That wealthy have gone upwards to the "archipelagos" of residential towers, roof gardens and heliports, or that in some cities people spend in elevators as much time as in public transport are just two examples out of many. But how do we put these transformations on the map? Despite all the limitations and challenges, we anticipate that further research in qualitative GIS will help to address this and many other challenges, advocating for social justice and multiple forms of knowing, overcoming quantitative/qualitative divide, embracing research as an open-ended process and informing better urban planning.

As a Way of Conclusion: So How Can QGIS Be Useful for Urban Researchers?

Qualitative and other critical GIS researchers have made a significant contribution to problematize the production of geographical knowledge, demonstrating how it is both shaped by society and shapes it (Leszczynski 2016; Sheppard 2005), and how technology both assists the research and poses new questions. But how this could be of use in urban studies?

The numerous examples in this article provide some clues. Perhaps first and foremost QGIS gives qualitative data spatial dimension (which is obviously relevant for the research on cities) — either through basic geocoding, creating databases in software such as ArcGIS or programming customized applications. Another important advantage is that it allows incorporating different sources of data (e.g. narratives and fieldwork notes) which quantitative GIS cannot

handle and to contrast them with the official data. This opens more possibilities for public participation and gives more context, depth and richness to the study. Finally, visualization makes the invisible visible, allowing discovering new patterns and, therefore, serves as a heuristic tool for research. All these benefits permitted the studies described above to shed new light upon relatively well-researched topics such as gender and the city, social exclusion, mobility or urban memories.

While the focus of this paper was solely on qualitative methods and quantitative methods were presented in a rather negative light, it does not mean, of course, that quantitative methods cannot be critical. A growing number of critical quantitative research in geography proves the opposite (Kwan and Schwanen 2009). This focus was stipulated by an aspiration to explore the role of qualitative methods in contemporary urban research. The examples provided in this paper aimed to illustrate how combining quantitative and qualitative methods, while not always unproblematic, may lead to rewarding results.

This paper attempted to bring a modest contribution to the ongoing discussion about transformations of geographical knowledge by putting current debates into historical context. It was also written in hopes that by learning from previous QGIS practices urban researchers will draw inspirations for new investigations.

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