Crowdsourcing Mapping and Participatory Planning Support System: Case Study of Brno, Czechia

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Abstract Many cities have started to engage their citizens in collaborative planning and in re-creating the urban spaces where they live. The case study presented in this paper crowdsourced subjective/emotional responses concerning the environment of the city of Brno in the Czech Republic, from 2,087 respondents, who marked 24,065 points on six different topics and added over 3,000 further comments. The paper presents not only the case study, but also the authors' own web-application called Emotional Maps—built for crowdsourcing spatial data, mainly about city development and subjective perceptions of urban spaces. The collected data showed three main hot-spots in the city, with a significant number of marked points reported by citizens. The paper comments on the reasons these spots are important for the citizens of Brno and their suggestions for future activities there. Furthermore, the authors argue that ad hoc flexible web-mapping platforms such as the one presented in the paper can be an asset to city administrations as well as urban planners.

Keywords Emotional mapping · Urban planning · Perceptions · Neocartography

1 Introduction

Urban planning is often elitist and non-participatory (Brooks 1988; Winter and Brooke 1993; Corburn 2003; Galdós 2010). But, the neglect of citizens as participants in the planning process is slowly changing as local political representatives

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start to understand that citizens have a relevant role in the processes of town planning and administration (Čermák and Vobecká 2011). Furthermore, current trends in urban planning support innovative instruments such as participatory urban planning (Kahila and Kyttä 2009; Kahila-Tani et al. 2015), emotional maps (Pánek et al. 2017) or open data (Jäppinen et al. 2013).

The idea of citizen participation in e-planning via geospatial technologies is grounded in the term GeoParticipation, described as a collection of methods through which communities can be involved in the creation of maps that help them be advocates for their environment and living space (Pánek et al. 2014). GeoParticipation is often linked with the process of community mapping as *"local mapping, produced collaboratively by local people and often incorporating alternative local knowledge*" (Perkins 2007, p. 127). Besides GeoParticipation, the concepts of Public Participation GIS (Obermeyer 1998) as well as Volunteered Geographical Information (Goodchild 2007) and Crowdsourcing (Howe 2006) play an important role. For detailed reviews about the history of Public Participation GIS please see (Schuurman 2000; Sieber 2006; Dunn 2007; Pánek 2016).

There is legislative support across Europe for public participation in planning and local decision-making processes. The first such ideas were published within the Aarhus Convention (1998) and subsequently, the Leipzig Charter on Sustainable European Cities (European Commision 2007). In the Czech Republic, participation is granted by the Constitution of the Czech Republic as well as the Act of Parliament 128/2000—Act concerning Municipalities (Czech Republic 2000).

Although research has questioned the function of participatory mapping (Reyes-García et al. 2012), public participation in urban planning can smooth the process and reduce the number of possible conflicts (Mapedza et al. 2003; Sandström et al. 2003; Cronkleton et al. 2010). It can also strengthen the understanding and acceptance of different values for the various stakeholders (Healey 1997).

The aim of this paper is to present the methods and the data gathered during the crowdsourcing participatory mapping event in Brno. The main research question is: Are there any significant perceived hot-spots in the city? Are there areas that draw controversy among the citizens of Brno?

2 Methods, Case Study Location and Data

The authors worked with the method and tool called *Emotional Maps*. The method is a version of participatory mapping that involves Gould-style (Gould and White 1974) sketch-able mental maps (Jankowski et al. 2015) used mainly in a web interface, combined with the answers to the questions that are placed directly onto the map. Opposite to comparative (Lynch 1960) preferential (Gouldian) mental maps are used to evaluate the quality of selected locations. The idea of using mental maps in geographical research is focused on recording a cognitive representation on paper, although GIS is often used to analyse the data (Waterman and Gordon 1984; Janoška et al. 2014).

There is an ongoing discussion as to whether emotional maps capture map emotions, perceptions, ideas and experiences. Nevertheless, the authors support the term emotional mapping, partly as a legacy of the book *Emotional Cartography* by Christian Nold (2009), and partly as their own research preference. Some authors prefer to use terms such as sentiment mapping (Caragea et al. 2014), hedonic mapping (Ennis and Ennis 2013), ephemeral mapping (Art and Cartography Commission of ICA 2015), perceptual mapping (Doran and Burgess 2011) and many others. The theoretical discussions and uncertainty about the terminology show that emotional mapping research and practice is not clearly defined or anchored in its respective disciplines. Nevertheless, Perkins (2009, p. 130) states that "*emotional maps chart human feelings onto a cartographical landscape … and allow users to devise and customise their own emotional landscape, to choose what kinds of thoughts and experiences, feelings and passions to map*".

The *Emotional Maps tool* (see Fig. 1; available at http://www.pocitovemapy.cz/index-en.html) is a web application built as a computer-assisted web interview (CAWI) with a map-based background. Similar to other web-based tools for crowdsourced mapping (Ushahidi, ArcGIS Online, or Maptionnaire), *Emotional Maps* allows users to collect spatial data on a multi-scale pannable map background, but it does not require the registration or installation of any specific software, plug-in or virtual server. The application is created as a single-page web application using two open-source JavaScript libraries. The crowdsourced data are saved in a MySQL database, available on most webhosting sites. Therefore, there is no need to have specialised hosting or one's own server with the geodatabase installed. Each entry in the database contains a unique user-ID (randomly generated), question identifier, number of points/lines/polygons marked and geometry.

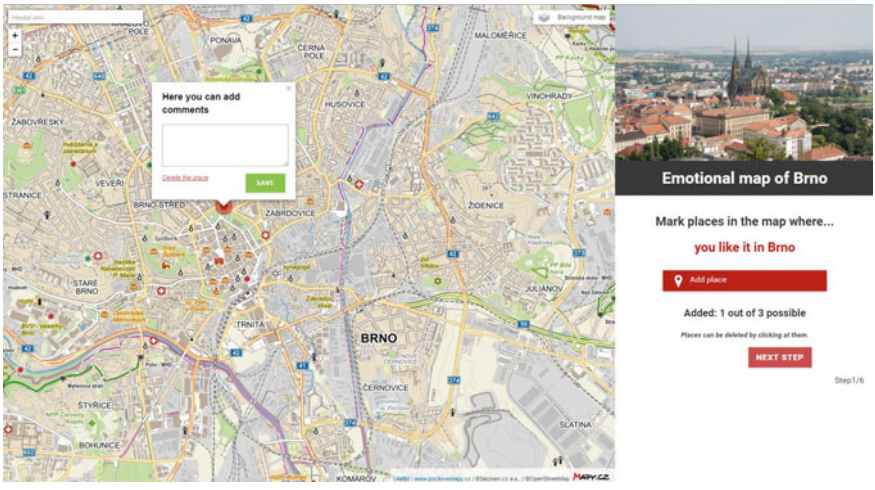

Fig. 1 The web application *Emotional Maps* used for collection of data. (*Source* http://www.pocitovemapy.cz/brno-2016-original/nahled)

These entries are later merged by a *GeoJSON PHP library script* (Mikola 2015) that allows GeoJSON to maintain data from multiple users.

The case study presented in this paper was implemented in May and June 2016 in Brno, the second largest city in the Czech Republic. The city has about 380,000 inhabitants (Czech Statistical Office 2015) and its greater metropolitan area is home to more than 600,000 people (SPF Group and Hope Group 2015). In total, 2,087 respondents took part in the survey. First, the authors met with municipal representatives to negotiate the themes that were to be researched through the emotional mapping activity, both online (through *Emotional Maps)* as well as offline (paper-based map survey). Hence the data were collected in two ways (1) via online survey (n = 1,093) and (2) during four days of the "*Week of the City*" event in one of the main squares. A total of 994 respondents (n = 994) created a series of paper-based emotional maps.

The link to the map was distributed via the city webpage and city profile on social networks, through mailing lists of local action groups, local newspapers, etc. This effort represented resulted in a snowball sample.

In May 2016, the city of Brno, via its department of Strategic Development, took part in the event called "Week of the City" where, over four days, citizens had the opportunity to create an emotional map of the city (the topics were the same as in the online (geo)questionnaire), with the results being merged afterwards. The questions asked via the online form, as well as via the emotional map, were intended to find the general public's opinions of the city. The respondents were asked six spatial questions as specified below and additional questions intended to identify the demographics of the respondents. With each spatial question, it was also possible to add comments where necessary in order to further explain an answer. Each answer was represented by a coloured pin (either digital or analogue) on the map. Up to now, the predominant method for spatially explicit preference mapping was marking points for locations or sketching polygons annotated with expressions (Jankowski et al. 2015). Brown and Pullar (2012) suggested that points instead of polygons be used in future PPGIS applications and it is also possible to use a fuzzy multi-point (Huck et al. 2014) feature to collect the information.

The spatial questions asked:

- Which places in Brno do you like? (4,327 points)
- Which places in Brno do you dislike? (4,079 points)
- Where do you spend your free time in Brno? (4,062 points)
- Where in Brno would you like to live? (3,829 points)
- Which places in Brno are you proud of? (3,868 points)
- What would you change in Brno? (3,900 points).

Although the idea was that both questionnaires would be identical and fully comparable, there were minor differences between the digital and analogue versions. When completing the analogue map on the streets of Brno, respondents were only able to mark one place per question, as opposed to the digital version, where the number of points was limited to three per question. This limit was set by the

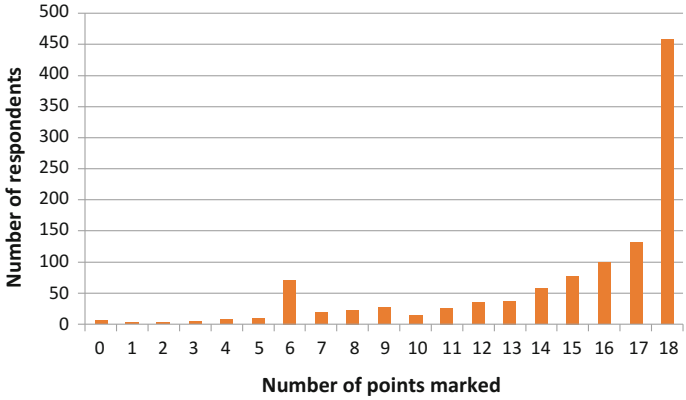

Fig. 2 Number of points used by respondents in the online mapping platform

Brno representatives and as can be seen in Fig. 2, the majority of respondents marked three points per question (i.e., 18 points in total). The digital version allowed the direct linking of respondents' profiles with the points they marked, but with the analogue version the points from demographic profiles had to be separated as the profiles were conducted separately.

The main disadvantage of the emotional mapping action on the streets of Brno was the need to manually digitise all the data via the online web application used for the digital survey. Nevertheless, the authors decided to use the street collection of data to ensure a broader range of answers as well as to gather information from a variety of target groups. For example, the street data collection attracted a higher percentage from the *older* generation, while the online form was mainly preferred by respondents under 30 years of age.

3 Results

The results from the case study can be divided into three sections: (1) demographic analysis of the respondents; (2) spatial distribution of marked answers; and (3) analysis of comments attached to marked points.

3.1 Demographics of the Respondents

Due to the sampling and the mixed methods of data collection, the results cannot be considered as a fully representative sample. Nevertheless, the sample is sizable enough to draw some conclusions. The variety of respondents also allowed the extraction of feedback that will be used in the forthcoming *Strategy of Brno*

document, as prepared by the Brno administration. The demographic structure of respondents from the analogue map is specific, with slightly more answers from females (59.4%) and a higher participation of respondents over 46 years of age. The youngest respondent was 7 years old and the oldest was 90. Almost half of the participants had a university degree. Most of the respondents (86%) lived in Brno and 2/3 had lived in Brno for more than 10 years. Of those respondents who answered that they live in Brno, the majority (74.6%) also plan to live in Brno in the future.

The online survey had slightly different structure of respondents as it had more diverse forms of promotion—the city website, social networks, etc. With the online mapping aspect, there were slightly more answers from males (55.7%) and, as was expected, the majority of answers came from respondents under 30 years old (54.3%). There was a much lower engagement of respondents over 45 years of age. Respondents who used the online version of the survey were most likely to be university educated (71%) and younger than 46 years old (89%). There were no other significant differences between the respondents between the paper and the online version of the questionnaire.

3.2 Spatial Distribution of Marked Points

In total, 2087 respondents marked 24,065 points on six different spatial questions. The respondents mainly marked places in the city centre, but there were also locations marked on the outskirts of the city, such as the Brno reservoir and the dam on the Svratka river just outside the city—a favourite spot for leisure activities. In the hotspot analysis, several areas were identified. Due to a lack of space, only three (see Fig. 3 for localisation) that contained the most points will be analysed in more detail: (A) the area around the main train station; (B) Špilberk castle; and (C) the excluded locality between Bratislavská and Cejl streets.

The area of the main train station in Brno (A) has been the centre of discussion for several years. Due to the frozen situation on the Brno municipal council regarding either the construction of a new train station or the renovation of the current train station, there is a lack of investment in this area. This situation is also confirmed by the 2093 points marked relating to the train station—the highest number acquired by any location. Of those, 1107 points were marked in the question *What would you change in Brno?* 28% of all answers to this question (1st in the spatial category), while another 986 points were marked under the question *Which places in Brno do you dislike?* (24% of all answers on the topic—1st in the category).

Špilberk is the castle on the hill in Brno (B) and its construction began as early as the first half of the 13th century. It was gradually turned into a huge baroque fortress, considered to be the harshest prison in the Austro-Hungarian empire, and then into barracks. In 1960, Špilberk became the seat of the Brno City Museum. The place was marked highly in three categories—*Which places in Brno are you*

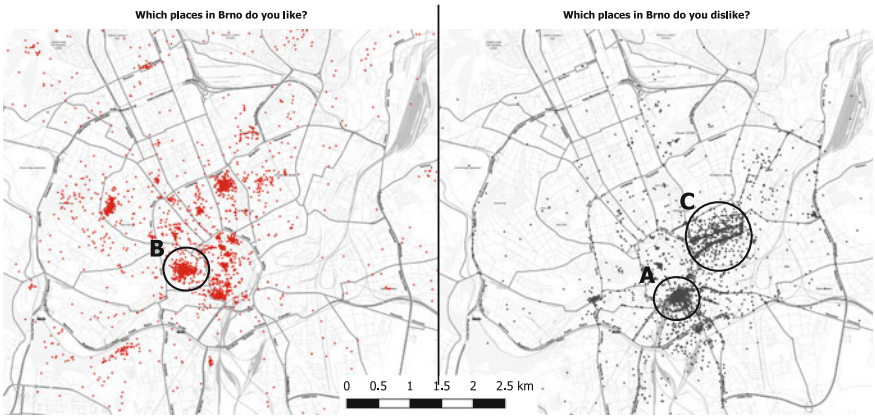

Fig. 3 Maps of answers to the questions *Which places in Brno do you like?* (*left*) and *Which places in Brno do you dislike?* (*right*). The letters (*A*, *B*, *C*) refer to locations described in the text (*Source* Background data—Stamen Toner Lite/OpenStreetMap)

proud of? (843 points marked—22% of all answers on the topic—1st in the category), *Which places in Brno do you like?* (492 points—11% of all answers on the topic—1st in the category), and *Where do you spend your free time in Brno?* (361 points—9% of all answers on the topic—3rd in the category).

The third area (C) that was heavily marked by points in same categories as the main train station is the excluded locality between Bratislavská and Cejl streets. Although close to the city centre, the area is widely considered as a place that needs change (664 points—17% of all answers on the topic—2nd in the category) and also a place that is disliked (967 points—24% of all answers on the topic—2nd in the category). With beginnings in the 16th century, the area used to be an independent village but now belongs to Brno. The locality is famous for the large community of Roma people (gypsies) as well as number of pawn shops, bars and gambling clubs (Fig. 4).

3.3 Why Were Certain Locations Marked?

Participants in the survey had the opportunity to attach a comment to each point they marked, both on the analogue map and on the digital mapping platform. In total, respondents added comments to 2,550 locations in the web map interface and about 600 further comments were recorded with the analogue map on the streets of Brno.

Some positive comments were:

- Multicultural city—*"like Brno more every day. Especially the development of cultural life and renovation of the environment (coffee places + gardens)."*

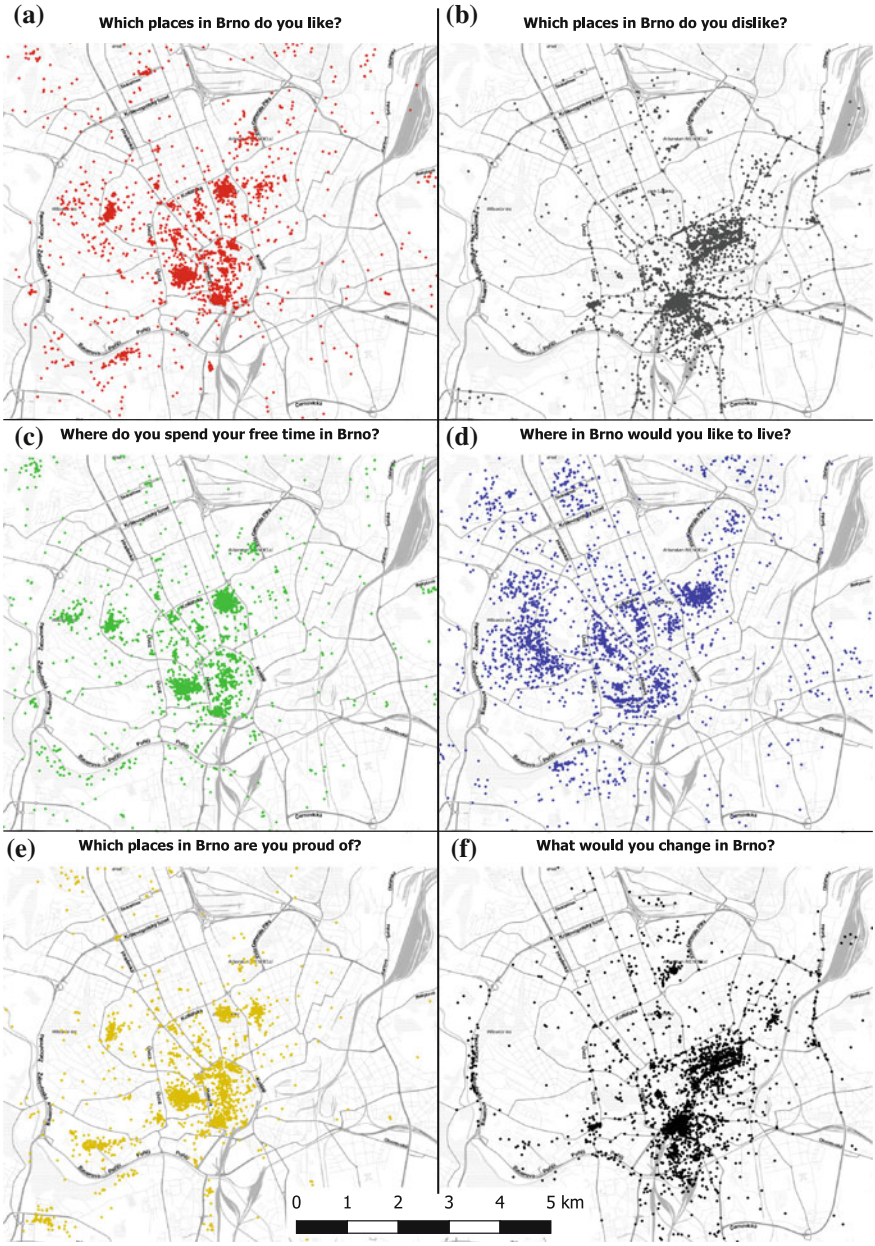

Fig. 4 Spatial distribution of answers for the centre of Brno. (**a**) Which places in Brno do you like? (**b**) Which places in Brno do you dislike? (**c**) Where do you spend your free time in Brno? (**d**) Where in Brno would you like to live? (**e**) Which places in Brno are you proud of? (**f**) What would you change in Brno?

- A city that is growing dynamically—*"I like it in Brno. The city works well. I think it is time for the citizens to move the city further, especially in the private sector in order to set up high-quality companies, shops, businesses. We have to create wealth and at the same time feel free. The city can only promote a good atmosphere, infrastructure and ideas. It is important to preserve the creative character of the town. The only specific thing needs to be addressed is the parking in the city."*
- Love and relationship to the city—*"Brno is a nice city and for the past 25 years has come a long way forward. I love Brno very much. The people are very friendly and seem to have very high standards and morals. Everyone has a high degree of respectability. When I am in Brno I feel lighter and relaxed."*

Some negative comments were:

- Insufficient cleanliness of streets and squares (garbage in the streets, chewing gum on the pavement, full trash cans, etc.)—*"Brno is a very dirty city (compared to other countries). Homeless on the streets/in a dumpster. Remove trash."*
- The poor state of the area around the main railway station—*"Brno has always been for me a matter of heart. I wanted to study here, furthermore, I found a great job, so I'm really happy here. But what I regret the most is the situation at the main railway station. The first thing people see when stepping off a train and come to Brno, the benches are full of the homeless and strange people. Is it really what we want to show tourists at the first sight? That's probably not a very good impression of an otherwise beautiful city full of great people."*
- Poor traffic conditions—*"Brno urgently needs to solve the traffic. Not only trains, but also tracks that are blocking the development of the city. Public transport around the train station needs improvement. Cycling—not just isolated pieces of cycling. Road—city circuit. Parking. The existing train station is a shame. It would be great at least to redecorate and clean it before the new one will be built." "More cycling safe zones! More lanes for cyclists on the roads. More bike racks (controlled camera system)."*

Comments specifically linked to the three most marked locations described above were:

- Main train station—*"I am ashamed of the main train station building" "Shame of the city", "Dirty, lots of homeless people, I never feel well here".*
- Špilberk—*"Špilberk is a symbol of successful defence against Swedish occupation (during Thirty Years' War)", "Impregnable fortress, nicely renovated", "Nice castle, view of the city, nicely renovated".*
- Bratislavská and Cejl street—*"Dirty, I would be afraid to go there alone", "Very busy and dirty part of the city", "Bronx in Brno, but it has a future", "Resolve Roma ghetto around Cejl and Bratislavská".*

4 Conclusions

The purpose of this research was for the residents of Brno to map a subjective image of their city. In collaboration with the city administration and in concurrence with the preparation of the new *Strategy of the City*, six map-based questions were asked and over 2,000 respondents marked more than 24,000 spots in the city and surroundings. The results of the case study will be further used by the city administration to move towards a more participatory and sustainable city planning.

Furthermore, the case study can serve as an example of crowdsourcing emotional participatory mapping used in the process of city planning and in negotiations over the future shape of urban spaces. Emotions and perceptions are a crucial part of modern cartography and a relevant source of information for city planners and decision-making stakeholders. Participatory crowdsourcing mapping applications, such as the one presented in this case study, can create a link between administrations and the public. As almost every place can evoke an emotional response, it is only logical that maps are used to collect these emotional reactions. Maps also help to communicate the perceptions and preferences in a space and with the tools of 'neocartography' and web-mapping, they could become a new platform for participatory planning.

We argue that there is enormous potential in participatory mapping and that crowdsourcing map-applications created ad hoc for specific mapping activities can bridge the technocratic gap between planners and the public. We are aware of mobile mapping apps such as EmoMap, SmellScaper and CitySourced, nevertheless, we understand that urban planning is a relatively complicated process, where citizens need time for reflection and to organise their thoughts prior to engaging in the mapping activity. Therefore, we do not see potential in mobile apps that are designed to collect immediate responses. Personal meetings (with the collaborative creation of community maps) and computer-assisted web interviews allow respondents to express the full depth of their thoughts and ideas.

There are three possible lines of future research with the dataset collected: (1) to explore mutual spatial correlation and demographic specifics within the data, (2) to compare our data with official census indicators, and (3) to analyse if place of living influences perceptions of the city.

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