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The role of Volunteered Geographic Information in participatory planning: Examples from Denmark and Finland

Anne-Marie Sanvig Knudsen og Maarit Kahila

Abstract
Due to developments in pervasive computing and the diffusion of digital media technologies, the amount of Volunteered Geographic Information (VGI) is rising rapidly. This paper investigates the potential of applying VGI to a participatory planning context. What kind of VGI was considered useful in the planning process and what were the strengths and weaknesses of the type of data collected? The paper looks at the methods and contents associated with VGI before looking at the implementation side of VGI. This is done by highlighting two case studies. One which was carried out in a Danish context, employing volunteered GPS tracking to capture everyday uses of the urban environment. The second case study was carried out in Finland, employing SoftGIS as a tool to identify and quantify place values.

Introduction

Imagine what your daily life would look like if you went off the digital grid: no mobile phones, no Internet, no credit card transactions, no train tickets, no groceries from the supermarket. The list is long. Cities are increasingly becoming enmeshed in digital technologies and networks: software codes and pervasive computers orchestrate and manage extensive flows of people and goods (Kitchin, Dodge 2011) and smartphone and GPS technologies are becoming well integrated in our daily lives, helping us navigate physical, social and digital networks around the city. Following this dramatic increase in and accessibility to user- and citizen-generated geodata over the past decade, the term Volunteered Geographic Information has evolved within the GIS community (Goodchild 2007).

We therefore believe it is relevant to take a closer look at Volunteered Geographic Information (VGI) as an aspect of Public Participation GIS (PPGIS), which addresses the more participatory and bottom-up aspects of GIS. In conjunction with this, an emerging field within planning the literature is exploring how location-aware technologies can be utilised to collect location-based knowledge in a participatory context (Evans-Cowley, Hollander 2010, Gordon, Koo 2008, Gordon, Manosevitch 2011) . Drawing on Elwood (2008), we aim to address VGI from three different perspectives: how is data collated, what constitutes data and, finally, how is data implemented? As Elwood points out, these aspects are important in shedding light on understanding how VGI might change the ability of citizens to collect and disseminate geodata.

By applying empirical data from two case studies in Denmark and Finland, we aim to illuminate how VGI "performs" in a participatory planning context. With its sensitivity to the processual aspects of the planning process, participatory planning approaches have been criticised of neglecting the issue of how information and knowledge might actually shape the output of the planning process; what kind of knowledge is needed and in what form (Brown, Weber 2012)? In order to address this critique, we also shed light on the more output-oriented side to VGI, i.e. what kind of VGI was considered useful in the planning process and what were the strengths and weaknesses of the type of data collected?

Two aspects to VGI: methods and content

In the following, we shed light on two aspects of VGI: methods and content. When looking at the case studies, we will additionally illustrate ways of implementing VGI. As we will demonstrate with the case studies, none of the three elements can be understood separately, they are closely interlinked.

Methods
As Goodchild (2007) notes, citizens have become sensors in a digital era where everything is locatable and networked (Gordon, e Silva 2011). This development is closely related to technological developments, enabling vast harvesting of volunteered information. Goodchild lists a number of properties which are crucial in enabling a new era of VGI: access to GPS technologies, geo-referencing and tagging, dynamic graphics and broadband communication. Within this technological nexus a number of new spatial data concepts are emerging, such as citizen science (Paulos et al 2008, Conrad, Hilchey 2011) and spatial data infrastructure patchworks(Coleman, Eng 2010, Budhathoki et al 2008). These developments can be summarised with the term humans as sensors - related to volunteered and geolocated "sensed" data. Examples of this spatial data concept are environmental monitoring carried out by citizens equipped with sensors – see the Copenhagen wheel as an example (Outram et al 2010), citizens reporting potholes to the local planning authorities with their mobile phones, as the citizens of Boston do via the Citizens Connect application (http://www.cityofboston.gov/doit/apps/citizensconnect.asp), or simply tourists geo-tagging their holiday snapshots on Flickr. This type of data sourcing is similarly related to an emerging research field within architecture and urban design, investigating the "sensing" ecologies between people, things and digital infrastructures in an urban context (Shepard).

Drawing on this, we would like to supplement Goodchild's review of VGI by briefly looking at how pervasive computing is enabling a continuous stream of realtime, situated data, drawing on everyday uses of the urban environment. Computers are not only found on desktops in our offices, they are everywhere, embedded in the environment and in our pockets and handbags. The Internet no longer resides in an abstract virtual world – it is present in every little nook and cranny of our everyday lives and everyday places. This shift, or way of computing, is often referred to as pervasive computing. Where cyberspace has us out of place, and pervasive computing - potentially - gets us back into place:

"Instead of pulling us through the looking glass into some sterile, luminous world, digital technology now pours out beyond the screen, into our messy places, under our laws of physics; it is built into our rooms, embedded in our props and devices everywhere." (McCullough 2005)

Along the lines of McCullough (2005), Gordon and de Souza e Silva (2011) argue that, quite literally, the distinction between bits and atoms no longer applies. Bits and atoms have instead merged as computing has become embodied and ubiquitous. When we carry location aware technologies with us, such as smartphones, information becomes localised, mobile and networked. What this essentially implies is that geo-information is collected, mediated, aggregated and distributed in a peer-to-peer fashion, enabling whole new forms of engagement with data and place. It is these affordances which will be explored with our case studies later in this paper.

Content
The networked, mobile interactions drawn up in the previous section add a complexity to place rather than making it redundant. The enrichment of location mediated through the entanglement of spatial information and situated computing, suddenly turn a seemingly neutral set of geographical coordinates into places, imbued with experience, emotion and memory. This happens every time we check into a location via the social media platform Foursquare or we post a picture on Facebook with a smartphone. As Jones et al (2008) show with the Rescue geography project, spaces and places, which on the surface seem mundane, become alive once memories and emotions are captured in a spatial context through GPS positioning. Dutch artist Esther Polak (2011)

equally captures the surprisingly rich embodied tales of the Nigerian dairy industry by GPS tracking cow herders and lorry drivers in her artwork “Nomadic Milk”.

The embodied interactions between technologies, physical environment, social context and user make for a fruitful nexus, where knowledge about how we use and perceive the urban environment emerge. This points to an increasing diversity in the type of spatial data we are able to collect, distribute and represent. Such developments should be included in the way we understand and conceptualise geographical information:

“These theorizations of the situated nature of spatial knowledge and the co-productive relationship between knowledge and identity may be woven into VGI research in many ways. Even early studies of VGI services show that contributors will seek to use these services to generate and share diverse forms of knowledge.” (Elwood 2008)

The technological developments outlined in the previous section enable exactly this diversity in knowledge production and representation, as pointed to by Elwood. Furthermore it addresses concerns amongst GIS critics as to whether marginal places, people and knowledge automatically become excluded by dominant quantitative GIS representations. VGI to a much larger extent enables qualitative data in an aggregatable and quantifiable format.

Surveillance is another relevant aspect on the content side of VGI. The opportunities of sourcing vast amounts of geo-data, enabled by GPS technologies and situated computing, are also followed by a call for ethical deliberations regarding the use of such technologies. Geo-data are telling and therefore sensitive. This became very apparent in the spring 2011 when a privacy scare erupted as it became known that Apple had collected location data on its iPhone customers without their consent. This was perceived particularly invasive as the information was stored on mobile devices, easily accessible to anyone with physical or remote access to the phones.

When we, as urban citizens and consumers, unsuspectingly produce geo-data, we clearly need some security that these data are not misused. Obermeyer (2007) calls for “new approaches to address spatial data privacy” to monitor what she terms “geo-slavery”. This somewhat bleak perspective on location-data is warranted; however, we would also argue that there are potentials in crowd-sourcing data and counter-surveillance which might help us in making our cities better and more inclusive. As will also be illustrated in our case studies, the distributed nature of VGI has the potential to jointly articulate issues and views on the urban environment, by tapping in on citizens’ own spatial data. This ties in with the idea of place-worlds while still keeping a focus on actual planning outputs.

Case studies

Following the discussions outlined in the previous sections, we now want to take a look at the implementation side to VGI. How is the participatory process as well as output strengthened by using VGI? These questions will be illuminated by introducing two case studies which employ VGI as a tool to increase the levels of citizen-generated information in a participatory planning context.

GPS tracking in Vollsmose, Denmark

The empirical backdrop for our first case study is the Vollsmose housing estate, located at the outskirts of Odense, Denmark’s third largest city. Roughly 10,000 people live in Vollsmose, representing over 70 nationalities and with a predominantly young population – almost 40 percent of its residents are under the age of 18. Planned according to modernist planning ideals, Vollsmose has a distinctively mono-functional, residential character. As a part of a revitalization process, a new master plan is being developed, which aims to transform Vollsmose into a

Fig. 1. Online visualisation of GPS tracks, Vollsmose

multifunctional neighbourhood. In order to include residents', particularly young peoples', perspectives on the neighbourhood, a methodological set-up, using GPS tracking in an online environment, was developed.
The aim of the Vollsmose survey was two-fold: to assemble spatial information about how young people use the infrastructure of the neighbourhood (output), and to create increased awareness and reflections amongst residents regarding qualities of living in Vollsmose (process).

Methods- GPS tracking with smart phones

As a new approach to GPS tracking, it was decided to test smartphones as a GPS mapping device for the survey. The reasons for using smartphones rather than the GPS device (Lommy Phoenix) previously used by the research team were many: 1) the smartphone allows for a more dynamic engagement with locality as the participant can describe the urban environment using text and image; 2) it was assumed that the participants would find it easier to remember to bring along a mobile phone rather than an external GPS device during their daily routines; 3) finally, smartphones allow for undertaking GPS tracking without having to invest in expensive tracking equipment – a perspective that potentially makes the methodology much more accessible in future research and assessments of the urban environment. The open source tracking application Open GPS tracker (downloadable for free from Android Market) was used as it allows for easy export of tracks in a KMZ format and the application also enables the participant to include text and images to their tracks in a straightforward fashion. It was also decided to create a Web interface that allows for an online visualisation of the tracks assembled by the participants (see Fig. 1).

Furthermore, a series of walk-along interviews were carried out using the participants' tracks as the starting point for conversation about everyday uses of the neighbourhood (Kusenbach 2003, Jones et al. 2008). This particular part of the research will not be reported in this paper.

Content- Vollsmose drawn with 40 feet

The GPS survey ran in May 2011 and 20 participants were asked to track their movements and geo-tag images and texts over a period of seven days. Throughout the survey the GPS tracks were visualised online, thereby creating instant feedback to participants and other stakeholders. In order to protect the privacy of the participants, their home addresses were blurred in a rectangle of 50x50 metres in the online visualisation. As Vollsmose consists mostly of multi-storey housing blocks, this method was deemed efficient to distort information about the participants' home addresses. Secondly, only information about user aliases, age and gender where made publicly accessible. Thirdly, the Web interface only showed 24-hour fragments of tracks, with a 24-hour delay, meaning that long sequences of location data, which could be sensitive to display, were not shown. Participants had to upload actively completed tracks and thereby real-time tracking was never an option. Finally, the Open GPS tracker only timestamps intervals, meaning that the visualisation of a track will only show where a given participant was, not when.

Based on GPS data collected throughout the survey, a series of GIS analyses was undertaken, exploring the uses of the infrastructures and green open spaces in Vollsmose. This output was used both as a tool to facilitate a dialogue with and between the participants as well as a data input into the master planning process.

What did we learn? Ownership and dialogue.

In the following we will briefly summarise the lessons learned from the Vollsmose case in relation to process: how did the method "perform" in a participatory planning process as well as the output, was the VGI considered useful and what were the strengths and weaknesses of the data?

Process

The initial idea behind the research project was to enable residents "to map Vollsmose with their feet". This was perceived as a positive starting point for a dialogue between planners and residents about how to develop Vollsmose in the future. The everyday use of Vollsmose was simply turned into tangible knowledge, captured and mediated by GPS tracking. Knowledge gathered throughout the survey was fed into the on-going process of assembling a new master plan, but also served to create collective reflections and deliberations on how to shape Vollsmose in the future, based on user-generated and place-specific knowledge.

As a processual tool, the VGI collected throughout the survey enabled a new dialogue format between planning professionals and participants, as the dialogue started from concrete citizen-generated inputs. The participatory aspect of the VGI is more indirect as we did not ask the participants to comment on a planned output. Rather, we asked them to share their everyday uses with us and by doing that a shared reflection on this practice was created. Through this reflection a qualified dialogue is enabled, which, in the end, might help create a more qualified and relevant output.

Output

On an applied level, the VGI collected in Vollsmose led to a series of GIS analyses, looking at the uses of local infrastructures and open green spaces.

Generally, boys were more "out and about" than girls (see Fig. 2). A multi-purpose sports pitch was very popular with the participants, particularly the boys. This pointed to an interesting dilemma when planning outdoor spaces for teenagers. Boys

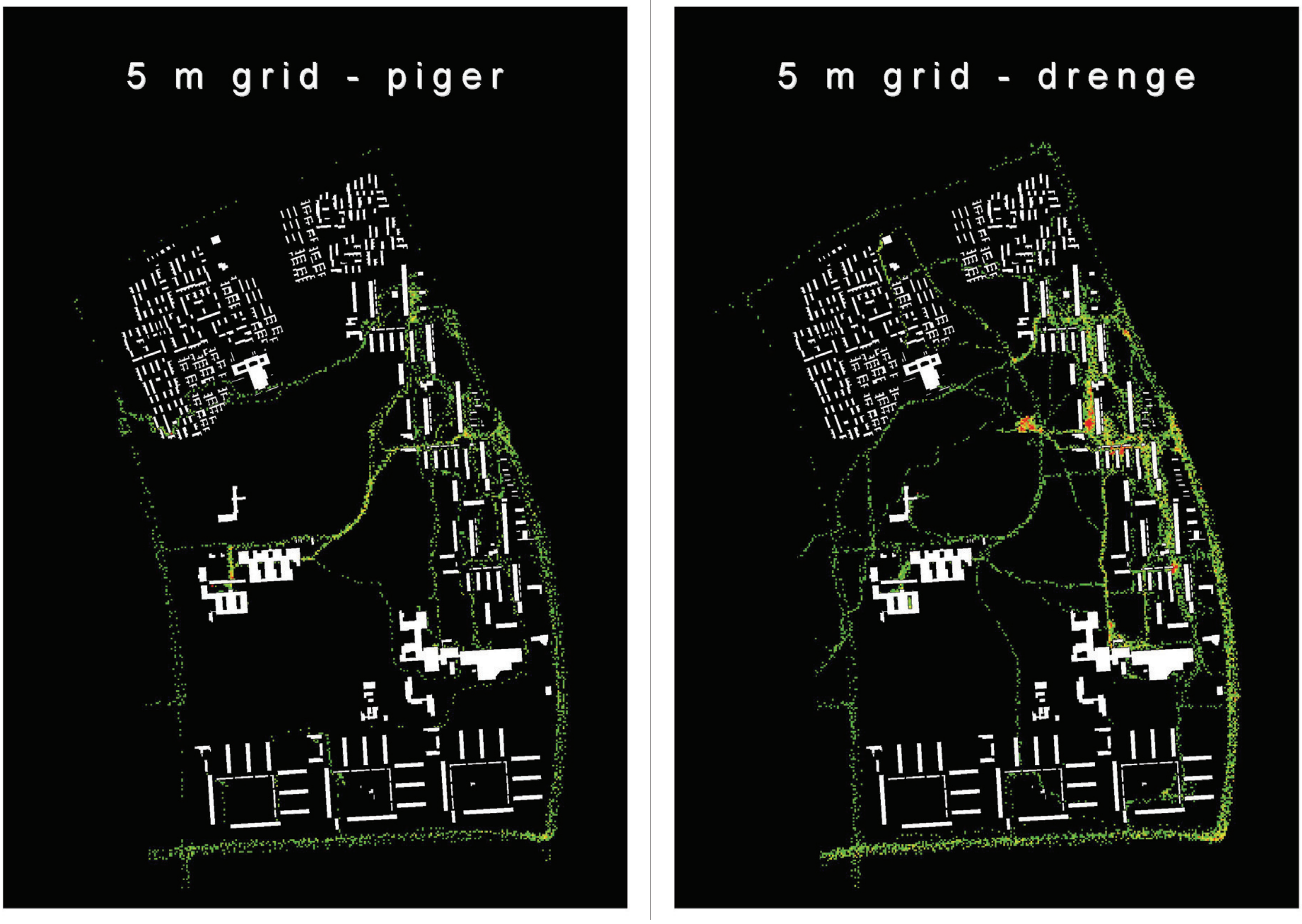

Fig 2. GIS analysis showing intensity of GPS data within a 5x5 metre grid, girls and boys respectively

enjoyed being "on-stage", playing football and basketball and thereby using the sports pitch as a stage to perform social interactions. Girls, on the other hand, were found "off-stage", socializing in small groups by picnic benches adjacent to the sports pitch. Factual data, describing gender-specific uses of public spaces, showed that this is an issue which needs careful consideration when planning urban environments. This observation was supported by a girl in a workshop where the survey results were discussed with the participants:

"Remember to design sports facilities for both boys and girls. I never saw a girl on a skateboard!"

With regard to open green spaces, during interviews and a subsequent workshop, the participants generally spoke positively about the open green areas in Vollsmose. Interestingly, the survey presented a different picture – the green spaces were hardly used. This information proved useful to the local planning office, as it enabled a qualified dialogue about how to activate these spaces, which represented an important mental value for the participants.

A deceptive quality of the GPS data is that it is factual, it represents peoples' actual movements. However, in this survey, the data is not representative, the sample is far too small. Therefore, data should never form the basis of an actual intervention, but, as mentioned above, form the basis of a qualified dialogue between citizens and planners. In this instance, GPS data were supplemented with qualitative interview data, which helped shed light on why and how the participants moved about the way

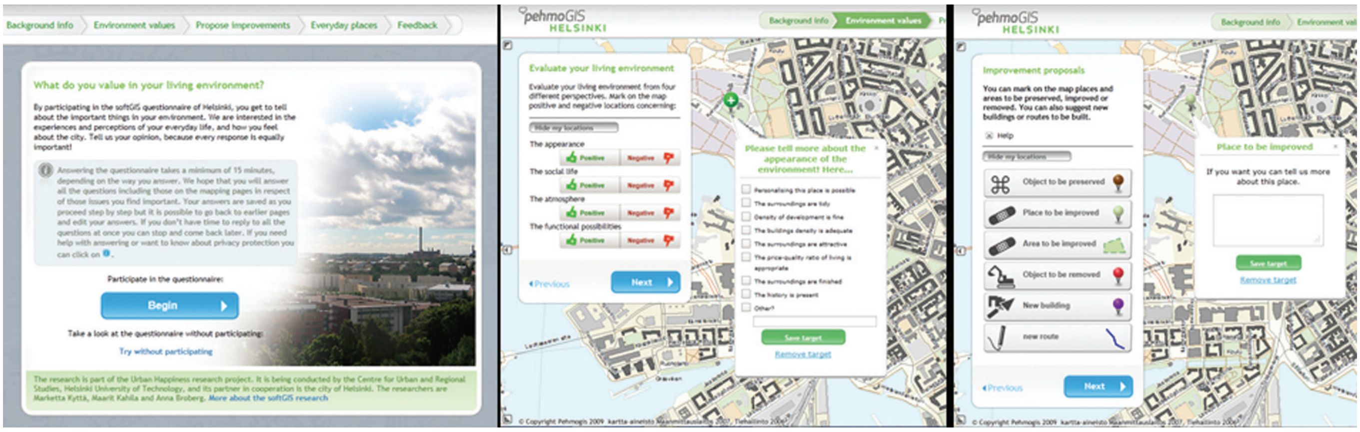

Fig. 3 SoftGIS method utilised in Helsinki and Espoo in 2009

they did. This also touches upon the ethical issues of working with location data. Issues which were addressed in the actual survey set-up: location-data are telling, while at the same time they never tell the full story. This aspect should always be approached with awareness and caution.

Using the SoftGIS method to map the neighbourhood characteristics of Kannelmäki and Leppävaara, Finland

Our second case study took place in Kannelmäki and Leppävaara, which represent typical inner city neighbourhoods of the Helsinki metropolitan area, which includes the cities of Helsinki and Espoo. Both Kannelmäki and Leppävaara are well connected to the centre of Helsinki by railway. Nearly 13 000 residents live in Kannelmäki and 24 000 in Leppävaara. Whereas Leppävaara has grown into one of the largest city centres of Espoo during the past 10 years, the number of new buildings in Kannelmäki has remained low. Both are loosely built and have a mixed structure, varying from high-rise to detached houses as well as from residential to business. Both areas are facing the pressure for change and transit oriented development (TOD) has gained attention. The densification and infill process has recently taken on a stronger role.
Kannelmäki and Leppävaara are two of the 11 neighbourhoods studied using the SoftGIS method in the Urban Happiness project. The study was implemented in 2009–2010 at Aalto University in the Department of Surveying and Planning, YTK – Land Use Planning and Urban Studies Group. The overall aim was to study the preconditions of an ecologically sustainable environment to function also as a socially sustainable setting. The research focused on urban environments that support social sustainability, such as easy access to personally meaningful places and the highly perceived quality of the environment (Kyttä et al. 2012). The project was conducted in close collaboration with urban planners.

Methods – SoftGIS in mapping out the neighbourhood characteristics

SoftGIS is an Internet- and geographic information-based method that studies residents' mapped experiences. The first SoftGIS study was realised in 2005 and has been further developed and applied in several studies nationally and internationally. The multidisciplinary SoftGIS methodology combines elements of environmental psychology, geography, urban planning and information and communication technology. In SoftGIS studies, lay people produce geographic information by locating their experiences of their living environment on a map (Fig. 3). The SoftGIS surveys used in the Urban Happiness project included 16 Web pages, of which eight were map-based (see www.pehmogis.fi/helsinki). A sample of 15 982 inhabitants from the Helsinki metropolitan area were approached via letter in the autumn 2009. Altogether, 3119 residents responded and the total respondent rate was 19.5%. From Kannelmäki, we reached 350 respondent and from Leppävaara 474. Respondents located altogether 10 234 points on maps.

With the SoftGIS method the residents evaluated their living environment voluntarily. This unique VGI produces mainly quantitative information and partly a qualitative one because the questions vary from categorised questions to open comments. The map-based questions allowed respondents to locate places of happiness, to evaluate the positive and negative aspects of their living environment, to make improvement proposals, to draw routes, to locate services and work places and, finally, to mark the perceived borders of their neighbourhood.

Urban planners wanted to allow the residents to articulate with the SoftGIS method how they define the positive and negative aspects of their living environment and what kinds of development proposals they have for the future. Planners wanted to test the capability of the SoftGIS method to collect place-based user information already in the early stages of the process and utilise this novel geographic information in their planning projects.

Content – Just dots on maps?

The following analysis of the data gathered with SoftGIS method is focused on map-based explorative analysis as visual data mining. The graphical analysis revealed hotspots – for example, concentrations of inhabitants' experiences to specific places. A quick look at the map visualises only some dots on the map, but by layering out the contextual and spatial side these separate spaces form structural spatial categories. As Van Herzele (2011) mentions, the formulation of structural categories is needed while it gives places a role in the planning concept, which again adds importance and even necessity to the displayed elements.

In both areas the respondents mapped more positive than negative places (Fig. 4). Negative locations cluster more strongly to specific places compared to positive ones. Positive places are located more often near homes and negative to public places. In Kannelmäki as well as in Leppävaara, most of the places of happiness are located in green areas and residential areas. In Leppävaara, these places are slightly more often located in public places compared to Kannelmäki. The place-based evaluations of the current setting indicate how people value their living environment and the improvement proposals highlight how they would like to change their neighbourhood. Places to be removed were mapped quite rarely; instead the respondents located more often places to be developed or places to be spared. The maps concerning the locations of everyday services disclose how the daily services of these neighbourhoods are scattered into sub-areas.

The following visual synthesis (Fig. 5) was made from both areas. It concentrates on three land use areas: residential areas, parks and public spaces. Under these categories the results are further categorised into three classes: (1) areas to be protected, (2) areas to be respected and improved and (3) areas to be developed. Respondents experienced positively the existing characteristics of places to be protected.

Respected areas were experienced mainly positively, only some improvement proposals and negative comments were mapped. Areas to be developed were experienced only negatively and gathered a lot of improvement proposals. The aim was to formulate the data to be better utilised as a communicative platform in future planning debates.

Green areas are highly valued in both areas and therefore categorised under places to be protected. However, some green areas are negatively experienced (dark green on map) and should be developed to meet the

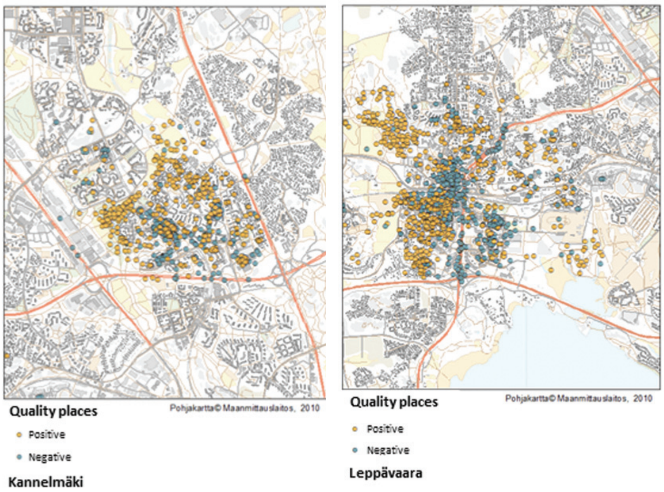

Fig. 4 Point-based data from Kannelmäki and Leppävaara

residents' needs. In Leppävaara, one green area to be developed from waste land into a park is located near the highway (number one on the map). In the middle of Kannelmäki, a green area is experienced as socially unsafe, where people still need to move around (number two on the map). From the residential areas, only areas that should be protected and, on the other hand, should be developed are found. The areas where services are located are not experienced as places to be protected. Even though areas are mainly negatively experienced these are experienced as places to respect. Only in Leppävaara the surroundings of the older shopping mall are very negatively experienced and the respondents strongly suggest it should be developed (number three on the map). This place has been left in the shadow of the new shopping mall and the area is deprived. Residents' evaluations of Kannelmäki and Leppävaara indicate strong polarisation. In Kannelmäki, residents value strongly the northern parts of the railway, and in Leppävaara the newer area at the southern side of the railway is experienced more positively.

What did we learn? VGI has potential, but

Next, we will summarise the results from the Kannelmäki and Leppävaara cases by considering the process: how the planners adjusted the method into their planning process and the output, how the collected VGI can perform in the planning process.

Process

Urban planners valued that with the SoftGIS method a large mass of geographic information was easily collected and they were able to reach this novel and mapped experiential information already in the early steps of the planning process. This notion was highlighted especially in this case where the planners knew that the Not In My Backyard phenomenon (NIMBY) would be strong. Planners sought a more locally sensitive process where residents would be involved already at the beginning of the process. Obviously, new participatory tools are needed to broaden the span of the participants while at least in Finland the existing participatory methods, such as a public hearing, reach a very small minority of inhabitants, and mainly older people.

Urban planners and researchers had differing demands towards the contents of the SoftGIS data. Concerning the method development, planners valued more direct questions about land use than researchers, such as the questions concerning improvement proposals. The planners had, nevertheless, a limited ability to formulate themselves the questions targeted at various inhabitant groups.

Output

Even though the VGI presented in this article forms just part of the collected experiential geographic information in the Urban Happiness project, it highlights two central notions of VGI: its versatility and extent. Transferring this kind of VGI data into planning practices, it easily ends up in a drawer and is not utilised profoundly. Concerning the analysis of SoftGIS data, the planners welcomed the analysis made by researchers and had little and varying capacity to perform GIS analysis and even less statistical analysis. In the future, easy-to-use,

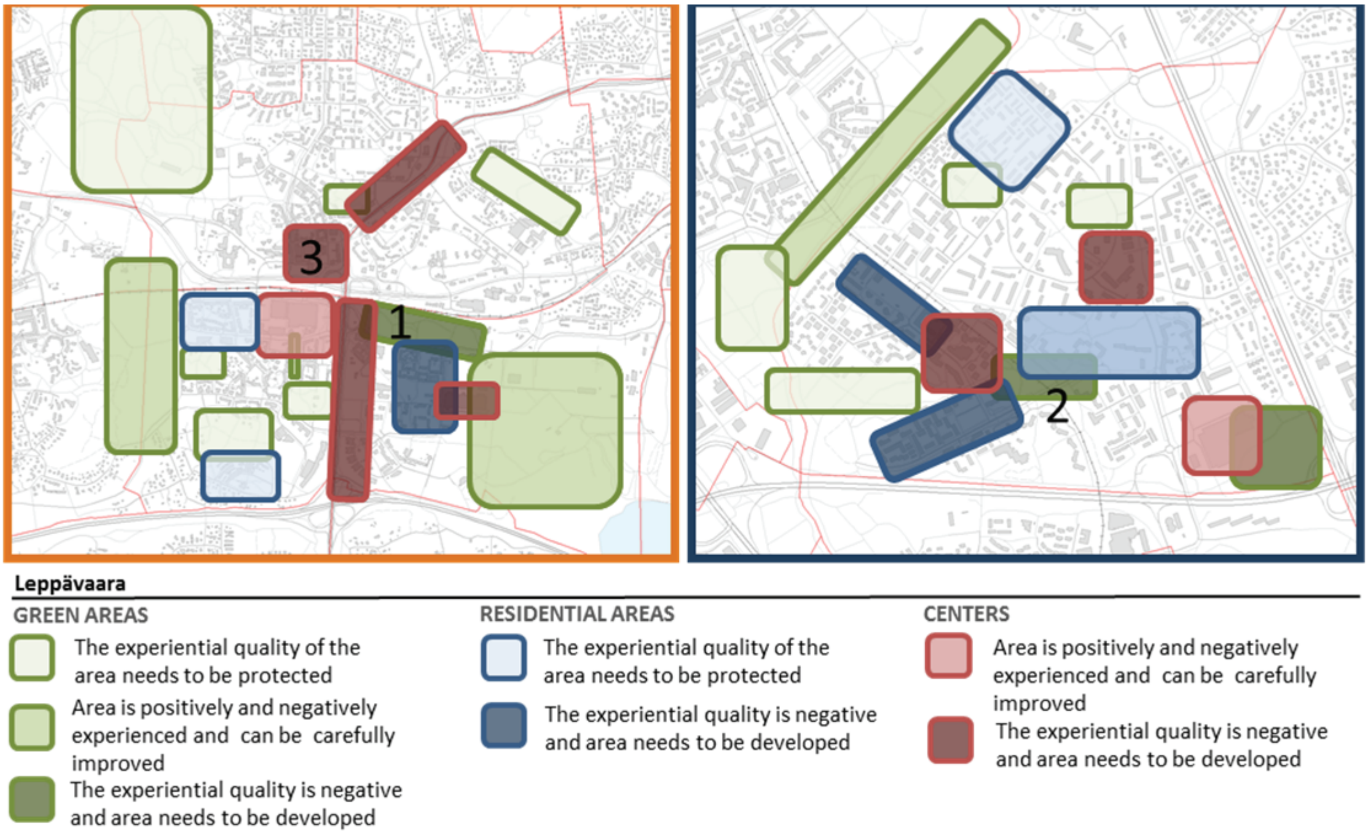

Fig. 5. Synthesis of the data and the neighbourhood characteristics of Leppävaara and Kannelmäki

preferably online data analysis tools should be developed for the use of planners and also inhabitants.

Because the existing participation process produces mainly negative feedback, the planners valued highly the collection of positive opinions. Planners also valued the visual synthesis made and utilised it in their discussions concerning the further development of the areas. They were surprised with the result that the areas are so strongly divided into subareas.

At the moment, VGI does not reach its potential and is often ignored in the decision making process and planning outcomes. Planners are willing to hear researchers' conclusions and results but the self-utilisation of the data remains at a low level, which might also be due to the varying cultural contexts of the planning institutions. If the data is not properly used in the planning process, its value also declines and, on the other hand, residents are not motivated to produce the data if they notice that data is neglected. Clearly we have now reached a situation where VGI, as in this case collected by the SoftGIS method, is valued a lot by urban planners. The next step is to indicate the full potential of the data and engage with it more profoundly in the planning process and outcome.

Conclusions and perspectives: towards a digitally supported planning process

Drawing on developments in pervasive computing and digital media technologies, Volunteered Geographic Information has become increasingly widespread. The aim of the article was to look at how VGI "performs" in a participatory planning context with respect to process as well as output.

In both cases studies, citizen-generated location-based data gave the planning practice valuable insights into how neighbourhoods were used, thereby forming concrete input into the planning process. The VGI collected and visualised throughout the Vollsmose survey facilitated a shared reflection on future uses of the neighbourhood based on citizens' actual uses. Equally, quantifiable information on these everyday uses helped inform on-going deliberations regarding design and planning solutions for the neighbourhood. However, care should always be taken when working with location-data, as they are sensitive, and while they represent actual uses they may not be representative. This calls for a high level of ethical considerations, also on the implementation and intervention side.

In the case of Kannelmäki and Leppävaara, use-generated inputs gave urban planners useful inputs as to how places were positively and negatively valued by the citizens and what kinds of improvements proposals they have for the future. The outcome revealed how the neighbourhoods are experientially strongly divided, which thereby qualifies the planning process at an early stage.

On the methodological side, as the case studies indicate, participatory planning processes can benefit widely by the dissemination of digital media technologies, whereby new methods are quickly developed and implemented, allowing easy access to collection of place-specific knowledge. Still, in order to proceed with digitising the planning process, some cautious steps are needed. New methods should be developed to support and supplement existing participatory planning methods and not make them redundant. This kind of 'soft' digitally supported planning process emphasises the need to collect place-based information already in the early steps of the process, utilising digital tools. The knowledge gathered allows the planner to utilise this as background information when designing a planning proposal. Both the plan (output) and the VGI (input) should be further processed in a deliberative manner, for example, in workshops. This helps inform a more iterative process, qualifying inputs as well as outputs.

For both cases, a new participatory format helped diversify the types of user-groups getting involved in the planning process. Still, issues of exclusion need to be discussed. Digital media technologies are widespread, but not all-encompassing. This restricts the type of VGI generated and might exclude less technologically well informed segments of the population. However, as both the Finnish and the Danish cases show, by employing digital communication technologies as a supplementary method, the participatory outreach was extended to new user groups.

A second challenge for future research in VGI is the output and implementation side. Even if our case studies exemplify how data is being used to qualify actual outputs, this aspect of VGI still remains under-developed. As demonstrated, the potential data harvest is vast, but we need methods to package and automate data in a format enabling planning departments as well as citizens to make use of data in a sensible way.

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