Submap: conceptualising relational space using information technologies

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Abstract

In this paper it is demonstrated how spatial information technologies can be employed to create imaginaries of cities abstracting relational and subjective spaces in the context of community planning. The governmental technology offered by Scottish Neighbourhood Statistics (SNS) called 'area profiling' is criticized for its inability to "enhance, rather than replace, dialogue" (Hoch, 2015) during collaborative processes. Using primary and secondary sources, this research understands that the conceptual design of traditional area profiles ignores the subjective dimension of space and an innovative technique is presented to address this conceptually. Cartographic design principles are applied to create 'Submap', a profiling techniques in which the spatio temporality of subjective space is symbolized and abstracted. Examples are given of different applications of this technique using a small N pilot study in the historic area of the Gorbals, Glasgow. Eventually, a spatial database relating the data content of Submaps to the data content of traditional area profiling is modeled and the possibility of crossing between the quantitative and qualitative chasm (DeLyser, 2012) is explored. In the next stage of research different methods for employing this technique are tested along with the validation of its influence on the cognitive processes of urban practitioners. This overall work will contribute to the development of a research framework for assessing the impact of specific profiling techniques on planning.

1 Introduction

By dissecting the spatial database used for 'Area Profile', it is understood how Scottish National Statistics are unable to represent the lived space of communities. The lack of spatial data semantically related to the subjective and relational dimension of space can be explained pragmatically and theoretically: on one side, it is not practical to integrate informal to formal data structures while, on the other side, the cognitive nature of the practice of planning has been ignored and wrong assumption have been made on the role f technologies in informing planning.

This research responds to the need of creating representations of cities capable of symbolizing relational and subjective lived spaces of people while influencing decisional processes. The online governmental technology of 'area profiling' is scrutinized for its ability to represent relational space and "enhance, rather than replace, dialogue" (Hoch, 2015). More specifically this research states that the conceptual design of area profiling tools offered from the Scottish Neighborhood Statistics (SNS) ignores the relational dimension of space. Based on a review of previous work on mapping lived space (e.g. Community mapping, Participatory Mapping) this paper presents an innovative representational technique addressing challenges which previous work have so far ignored, namely design, scales and temporality.

Cartographic design principles are applied for creating 'Submap': a map –and the techniques needed to create it- in which the spatio temporal dimension of subjective space is represented and symbolized. Examples are then provided of different applications of this technique using a pilot study in the Gorbals, Glasgow. Eventually, a conceptual model for a relational spatial database relating the data content of Submaps to the data content of traditional area profiling of SNS is proposed.

Before proceeding with the physical modeling of such database, the next stage of research will test a series of methods for producing Submaps and validate their ability to promote sense making activities in different Communities of practice in planning (local communities, planners, architects, housing associations etc.) in comparison to traditional area profiling techniques. Lastly, a research framework will be created for evaluating the performance of area profiling technologies in the practice of planning.

2 Background: why representing lived space?

2.1 Urban regeneration and social displacement

> "We are not building cities for people to live in; we are building cities for people to invest in" (Harvey, 2015)

In the last three years, Inner London boroughs have moved 50000 families to outer London neighbourhoods as a result of soaring rents (Douglas, 2015). This process is not new to urban planning history: in 1946, Sir Patrick Abercrombie's Clyde Valley Report stated the need to disperse between 250,000 to 300,000 people from central Glasgow (Maver, 2014) in order to address urban decay. After 70 years, Glasgow remains 'root-shocked' from such mass displacement making it the perfect example for scholars writing about the idea of planning as intrinsically dealing with "problems from the past". In the last thirty years, UK growth strategy for post-industrial cities like Glasgow has been the one to literally 'make space' in well connected city centres for Financial Districts and affluent communities. In 2011, Glasgow was in the European top fifteen Global Financial Centres which measured 75 financial centres across the world (Z/Yen Group and Qatar Financial Centre Authority, 2014). One year later, In 2012, Greater Glasgow scored the highest level of self-reported poor health measures among 33 other European cities (Grey et al, 2012) calling for a critical analysis of the relationship between growth and prosperity.

Spatial decision making processes (SDMP) and the Communities of Practice (CoP) involved in them, are often the focus of studies in urban research willing to understand the phenomenon of social displacement and social segregation in relation to urban regeneration undergoing the umbrella term of 'gentrification studies' (Atkinson, 2000; 2008). Different methodological lens would provide different perspectives on the matter. For example, political economy approaches identify 'markets' and 'governments' as fundamental variables to understand gentrification which does not only influence values and rules of SDMP (Smith, 1979;1987) but also affect the implementation of technologies within them (Georgiadou et al. 2010).

Distancing itself from political economy approaches, this research takes a socio-ecological approach to gentrification identifying the 'individual', the 'environment' and the relation between them, as important variables for understanding the paradoxical relationship between urban regeneration and social inequality. In addition, it is understood that, regardless how enlightening results from political economic studies could be, their ability to eventually improve SDMP is limited by the very ability of SDMP of improving themselves, in other words, of 'learning'. It is then suggested that there is a need to better understand cognition in SDMP acknowledging both the role of organisational inertia (Hannan et al, 1984; Kelly et al. 1991) as well as the potential of reflective learning and evaluation in achieving effective SDMP (Sanderson, 2002). However, it is not the aim of this particular paper to study learning in SDMP on a theoretical level, but instead, to provide practical examples and techniques of how information technologies in existing planning practices can be designed to promote sense making, a key activity of reflexive social learning, in the context of gentrifying cities.

2.2 Learning from the past: the idea of collaboration

Planning authorities willing to learn lessons from past regeneration experiences have engaged in promoting more socially inclusive and collaborative approaches involving stakeholder engagement to ensure that local communities have a voice in planning. These movements have their roots in 'Urbanism' theories of 'advocacy planning' and 'communicative planning' which attempted to break from the traditional 'land-use' and 'zoning' driven planning cultures. However, moving from manipulative and consultative stages of participation to the empowerment of communities (Arnstein, 1997) has demonstrated quite challenging (Lawson L. et al. 2010) calling for an exploration of better strategies considering the paradoxes of control and collaboration in governance (Sunduramurthy et al. 2003, Whitehead M. 2003). Similarly, the non-transformative nature of collaborative processes legitimates traditional power structures of SDMP and reinforces existing inequities (Plummer et al. 2007, Swyngedouw 2005, Van Bortel 2009). Consequently, a deeper and more detailed analysis of the existing codes and forms 'making' collaborative planning is needed in the view of their 'purposeful manipulation' for better learning.

2.3 Spatial representations for planning: including lived spaces

> "What human beings are and will become is decided in the shape of our tools
> no less than in the action of statesmen and political movements" (Feenberg,1992)

After setting the need of improving learning in decision making processes to prevent the conscious or unconscious 'planning' of social displacement, polarization, marginalization and segregation (Kohn, 2013) through urban regeneration, the spatial unit of the neighborhood is isolated to carry out a theoretical and practical investigation into how tools implemented during SDMP can better represent the social dimension of lived space and improve learning.

Although having anticipated that no political and economic approaches are used to address the problem of gentrification in post-industrial cities in this study, the two particular political contexts of 'representative' and 'participatory democracy' are needed to be taken into account because learning would be interpreted differently depending on the political setting. As The Bill for the Community Empowerment Act of the Scottish Parliament was passed by the Parliament in June 2015 and received Royal Assent in July 2015, spatial realities represented through information technologies are needed to be conceptualized with a strong outlook to the 'social dimension of lived space'. Lewin's seminal work (Burnes, 2004) on group environment at the beginning of the 20th century culminated into the conceptualization of field theory explaining how the relation between the individual and his/her environment shapes, rather than dominates, the other; moving beyond the traditional nature vs nurture debate, individual behavior becomes a function of the group environment or 'field'". Lewin indicated that "whilst there might be a rhythm and pattern to the behavior and processes of a group, these tended to fluctuate constantly owing to changes in the forces or circumstances that impinge on the group" (Burnes, 2004). By applying this knowledge to the social group of people living and interacting within a neighborhood, it is recognized that there might be original patterns of lived space but that such pattern are in constant change as they are influenced by certain environmental forces at different levels. Moreover, Burnes (2004) underlined how such changes were intended to be slow but that, "under certain circumstances, such as a personal, organizational or societal crisis, the various forces in the field can shift quickly and radically". In such situations, established routines and behaviors break down and the status quo is no longer viable; new patterns of activity can rapidly emerge and a new equilibrium (or quasistationary equilibrium) is formed". More recent work on socio ecological system theory shows how transformability is the "Capacity for the system to create a new system when existing one is untenable". Nevertheless, it is important to avoid associating change and transformability to the positive traits of a social group since "transformation is at times undesirable even if current state is unsatisfactory" (Kaufman,

2008). From this perspective, change is not the solution to crisis but, instead "the key to resolving social conflict is to facilitate learning and so enable individuals to understand and restructure their perceptions of the world around them" (Burns, 2004). For individuals willing to understand the nature of crisis, like, for example, the ones experienced by a societal group affected by displacement or segregation, it is important to access representations of the forces in the field of this group of people at personal, organizational and societal levels as well as their routines and activity patterns. Calculative artifacts (Ryidin, 2015) employed in planning using Geographic Information Technologies hardly conceptualize routines and activity patterns within a social group focusing instead on the conceptualization of 'individuality' e.g. 'income', 'ethnicity', 'age' etc. These artifacts are then criticized for their inability of representing the relational dimension of space in which behavioral and activity patterns can be studied opening up new avenues of research to explore different techniques leading to the production of spatial representations inclusive of relational subjective spaces.

2.4 Governmental technologies: metrics and new metrics

> "Any account of a potential technology needs to avoid reading governmentality into outcomes (Cherney, 2004) and assuming that a particular technology will deliver a particular rationality. Instead, it needs to pay attention to the actual engagement of actors with such technologies and to the contingency of particular cases, rather than assuming that the implication of adopting a particular policy tool is effective `conduct of conduct'." (Rydin, 2014)

The tools adopted during spatial decision making in shaping our cities have to be recognised and considered as active shapers of cities. In the same way a magnifier allowed us to better understand the functioning of human organs moving beyond the limits of a cognitive system with poor sensorimotor skills, remote sensing technologies such as aerial photography, transportation monitoring, environmental sensors and cameras, allowed us to access information about cities we would not be able to access as limited by the constraint, for example, of being unable to be in two different places at the same time. However, there is a subtle difference between these two technologies: while a magnifier put the object and the observer in a direct relationship by improving the quality of the lenses through which we look at the world, remote sensing is, by definition, 'remote', and removes the physical contact between the object and the subject. Spatial representations of cities produced using surveying technologies have then the peculiarity of removing the physical relationship between the observer and the phenomenon and, whenever a physical connection is broken, something like a representation is required (Chemero, 2011). In the context of this research, three limitations of current representations of the spatial unit of 'neighborhood' are found in the literature: subjectivity, multiple scales and temporality (de Ham et al. 2013).

From this perspective, planners, unless planning their own lived spaces, deal most of the time with representations of spatial realities which is what the critical work of Lefebvre on the three parts of the dialectic of space (lived, abstract and conceived) discusses (Lefebvre, 1991). It is then argued that representing both abstract and lived spaces during decision making can accelerate a holistic understanding of cities and eventually improve decision making. Before proceeding with such endeavour, it is important to identify the mechanisms, structures and rules of spatial representations in planning as well as the methods and elements used to produce them. This is done by dissecting the content of the spatial datasets used for area profiling by the Scottish Government (2015) and observe the gap within the existing database structure of spatial information which can be semantically related to the societal need of 'relatedness' (de Haan et al. 2014). Moreover, direct observations[1] of contemporary efforts in providing 'alternative' representations of cities, revealed that existing representations of relational space, because of their informal data structure, cannot be

[1] The researcher has followed the initiative of community mapping organized in Glasgow as part of the bigger Future city agenda worth £24m (Future City, 2013) and got actively involved as a volunteer in a Community Mapping project for a Charity for people with learning and physical disabilities.

integrated to existing formal spatial database which exist in planning support systems like Geographic Information Systems, remaining therefore marginal tools to decision making in planning.

It is then iterated that reviewing the design of Spatial Information Technologies (SIT) and spatial data infrastructure (SDI) could be " an important experiment in governance that may be transformational not only to our identities as planners, politicians, or communities but also to the relationships that are shaped between us" (Miller, 2005). These tools are adopted to facilitate and mediate abstraction processes of future spaces (Feenberg, 1992) leading to the generation of "alternative ways of knowing to open up new possibilities at the level of interpretation and represent a vehicle to change, learning and transition" (Lagendijk et al. 2014). Lagendijk et al (2014), uses the word 'metrics' to describe abstractions used in planning for the representations of spatial realities; metrics can therefore be interpreted as the spatial datasets of variables relating to employment, access to services, education, pollution in a specific spatial unit (e.g. the datazone in the UK, or the Census Tract in the US) like n. of people using the local library, n. of people holding a degree, distance to contaminated site etc. In this paper new metrics are presented which can be used to collect, store and retrieve spatial information on 'lived space' by adopting the codes and forms of Information Systems implemented in current practices.

3 Literature Review

3.1 Previous work in representing subjective spaces

The definition of 'lived space' as "directly lived through its associated images and symbols" (Lefebvre,1991:39) suggests that lived spaces are essentially subjective and collection methods of subjective data belong to qualitative science. The field dealing with representations of qualitative data in GIS is known as "Qualitative Geographic Information Systems" (QGIS) and spans between the fields of machine learning, artificial intelligence, feminist and public health research. The introduction of qualitative data in GIS enabled, for example, the exploration of natural language variations associated with different spatial variables (Shariff et al. 1998, Xu 2007, Eisenstein, 2014) as well as the identification of gender, age and cultural differences in spatial activities patterns and experiences of place (Kwan 2000, Mennis et al., 2013, McLafferty, 2005). These studies demonstrate an emerging approach in research for integrating qualitative data and qualitative analysis to traditional GIS defined by Jung et al (2010) as Computer Aided Qualitative GIS (CAQ-GIS) which "enable researchers to take advantage of the geo-visualization and spatial analysis capabilities of GIS as well as the qualitative analysis tools available in CAQDAS".

Methods adopted in Qualitative GIS are essentially mixed as they can merge ethnographic methods and narrative analysis to spatial statistics (Pavloskaya 2002, Matthews et al. 2005, Bagheri, 2013, 2014, Curtis et al. 2014). Research in Qualitative GIS has been on the rise since 2002 and date back to the early work of Hagerstrand (1970) on time geography as a discipline in which the geography of everyday life is understood in terms of "the interaction between space and time and their joint effect on the structure of human activity patterns in particular localities" (Kwan, 2002). Time geography analyses human activity patterns and movements in space-time requiring detailed individual data and representations of space including the dimension of location, timing, duration, sequencing and type of activity; these are often used to explore migration, residential mobility, shopping travel and commuting behaviour useful for neighborhood planning.

A Qualitative GIS mixed method approach fits the purpose of this research, enabling the 'lived space' of neighborhoods to be represented in tandem with existing quantitative approaches which mainly draw on the 'space-time of human activities' originally developed with the purpose of exploring patterns in household activities and travel behaviour (Kwan 2000, 2006, 2014; Weber et al 2002, 2003).

3.2 Representing phenomenological 'lived space': from limitations to opportunities

The concept of phenomenological 'lived space' is approached via the notion of neighborhood. The vision of a neighborhood as self-sufficient container was introduced by urban ecological theories of the early 20th century like the garden city (Howard's, 1902) and Burgess's concentric model, and has persisted as a sociological orthodoxy until recently (Chaskin,1997); two main problems have emerged in the literature as a result of adopting representations of neighborhoods as bounded, static and a-temporal phenomena summarized in Kwan (2012): the first is known as the uncertain geographic context problem (UGCP) and it arises because of' the spatial uncertainty in the actual areas that exert relevant contextual influences on each individuals under study'; the second is known as the modifiable area unit problem (MAUP) in which 'analytical results are biased by the zoning scheme'. Meanings and definitions of neighborhoods have clearly evolved as limitations of different interpretations were being unveiled. Van Ham et al (2013) makes a synthesis of the necessary shifts for carrying out studies on neighborhoods considering both UGCP and MAUP providing a theoretical framework for this work in which (selecting only a few of his recommendations) :

-Studies need to focus on the relationship between the built environment and the subjects of the neighborhood
-Subjective data should be considered
-The temporal variable should be considered (people's and places' histories)
-The spatial variable should be considered to broaden the neighborhood's horizon and include other spatial context which matter in addition to the residential neighborhood

Following this, it is understood why Qualitative GIS methods mapping subjective spaces of neighborhoods should directly engage with communities to spatially represent subjective and experiential spaces. In the context of information technologies for planning, these methods undergo the umbrella term of Participatory Geographic Information Systems (PGIS). PGIS methods aim to engage non experts to identify the spatial dimensions of social and cultural landscapes (Brown et al, 2014) via the implementation of different methods developed in virtual environments and digital game with the overall aim to improve participants' immersion by focusing on "the depth and breadth of user experience" (Gordon et al. 2011), therefore enhancing participation. PPGIS is described by Tulloch (2008) as "the field within geographic information science that focuses on ways that the public uses different forms of SIT (Spatial Information Technologies) to participate in public processes such as mapping and decision making. Private GIS-based businesses and public GIS-based services are growing in cities adhering to the smart city agenda and often provide tailored packages (phone applications) of map-based software tools. Users of these toolkits are citizens and there is a need to ensure that such information can be used to inform decision making processes at a city planning level. However, the formal structure of traditional Planning Support Systems such as Scottish Neighborhood Statistics discourages the utilization of unstructured spatial data ,such as subjective mappings, during traditional decision making processes. In order to address this barrier to collaboration, the following section shows how subjective spatial data could be formalized via the creation of 'Submap': a map of subjective spaces moving beyond a positivist approach to human geography. Examples of Submaps are provided in this paper and they will be validated for their ability to trigger sense-making in different Communities of Practice (CoP) in the next stage of research. The paper concludes with presenting a sketch of how a relational database including both subjective spatial data and official Scottish Neighborhood Statistics would look like opening up the possibility of integrating quantitative and qualitative for area profiling.

4 Extended Mapping and Submap

4.1 Extended mapping: maps as processes rather than knowledge

Cartographic design principles are used to guide the creation of new spatial representations. The first step in cartographic design is to consider the real world distribution of the phenomenon which is being represented (Slocum et al, 2014:240). Based on a literature review on space time geography and neighborhood research, it is understood that this is not possible when representing relational space since there is no such thing as a 'one real-world distribution' in subjective space but multiple 'real worlds' are accepted. From this perspective, spatial representations themselves are not interpreted as final products but as *processes* for investigating individual meanings of relational space and the possible existence of a collective relational space by representing cumulatively different individual spaces and identify patterns: this agrees with Montello (2002) who suggests that maps do not necessarily communicate knowledge but rather, stimulate and suggest knowledge through the transmission of information (Slocum et al. 2014). In order to distinguish this kind of mapping from the mappings in which spatial realities are defined and evaluated we define these mappings 'Extended mappings' for their ability to contribute to a process of sense making rather than merely communicating spatial knowledge and accepting the possibility of the existence of multiple distributions of the same pheonomenon.

In the second step of the design process the purpose of the map should be determined (Slocum et al, 2014). As stated above, the purpose of this work is to add on representations of subjective spaces to decision making processes while considering the spatio-temporal dimensions of lived space. Neighborhood studies associate social networks, spatial occupation patterns, activities, residential history, perceived safety, perceived neighborhood, perceived landmarks etc. to the concept of lived space .By taking a pragmatic approach, six face to face in-depth interviews to planners from four different Local Authorities in the West of Scotland were carried out to discuss the relevance of different socio-spatial concepts to decision making in planning in order to test their validity in a practice based context. These interviews resulted in the selection of fifteen elements to generalize and abstract subjective space during the phase of conceptual modelling (Table 1). Before showing how the spatio-temporal dimensions of these elements can be represented using cartographic devices, it is important to take another crucial step of cartographic design which could strongly influence the breadth of sense-making during decision making processes: identifying the intended audience.

ELEMENTS OF A SUBJECTIVE MAP (SUBMAP)	
Submap spatial	
	My home
	My people
	My perceived neighbourhood
	My spatial movements in a typical week
	My perceived changes (positive, negative, indifferent)
	Place/s I think require change
	Place/s I want to stay the same
	Place/s I go often to in my free time
	My problematic areas (where I experienced problems in the past)
	My food shop/shops
Submap spatio-temporal	
	Residential history since date of birth
	Future prospect of moving out the area? Reason? Where to?
	How many hours per day outside your home
	How many hours per day outside your neighbourhood
	How many times away from home for more than one week in one year

Table 1: Selected elements representing spatio temporal patterns of subjective relational space

4.2 Sense Making and Gestalt psychology

> "Because we do not believe there is any single correct 'solution' to such challenges –of contemporary urban theory-, our questions are intentionally open-ended. The goal, we repeat, is to open up horizons for thought and action, and through collective dialogue, investigation and debate, to begin to explore these horizons." (Brenner, 2010)

The identification of the audience of a map is another important prerequisite to map design; different user groups will in fact have different previous experiences with map reading as well as with the phenomenon being represented. It is possible to imagine how a map of the geology of Scotland could differ if it was for 10 years old students or 25 years old Geology graduates student. In a context of collaborative planning, representations of subjective lived space are intended to address different communities of practices (CoPs) involved in collaborative decision making such as community groups, architects or researchers. The common denominator between these groups is their interest in the socio-spatial processes of a specific area and their will to engage in some kind of sense-making activities. The purpose of subjective spatial representations is to create representations of relational space to different communities of practice involved in decision making processes of regeneration at different stages and trigger different sense making activities that can be used " through collective dialogue, investigation and debate to begin to explore horizons for thought and action" (Brenner, 2011). In order to achieve this, it is important to get some basic understanding of how our cognitive vision system organizes spatial information and, both consciously and unconsciously, influence our generation of meaning. According to Gestalt psychology (Wagemans et al. 2012), Bertin's (1983) principles of spatial organization such as closure, proximity, similarity are important criteria of relevance of spatial information for all users and choices on color, contrast, spatial hierarchies, size and other visual variables can be manipulated to make sure that confusion and clutter do not interfere with users' spatial organization processes. To illustrate the relevance of carefully selecting different visual variables in the spatial representations of lived space some examples are provided using the Submaps produced in the exercise carried out in the Gorbals.

In Figure 1 the Gestalt principle of 'proximity' is used to identify certain patterns of utilization of place during the free time of three different subjects. In Figure 2, different areal size shows the diversity of perception of neighborhood while in Figure 3, different linear size, color and spacing show different mobility levels at different scales for three different users. In Figure 4, the qualitative phenomena of 'perceived changes' (good or bad) is represented using the visual variable of color hues and, through the Gestalt principles of 'similarity' one understands that there is more positive rather than negative elements in the map. After demonstrating how different visual variables can influence sense making, the following paragraph illustrates how the challenges of representing multiple scales and temporality have been addressed.

4.3 Submap: a techniques for including multiple scales and the temporal dimensions in the spatial representation of lived space

No research has previously attempted to provide spatial representations of lived space which collect and represent data both at multiple scales (from local to global) and consider the temporal dimension within GIS. Creativity was essential to address these challenges and develop a mapping technique called 'Submap' for collecting and representing spatial data at multiple scales and including temporality.

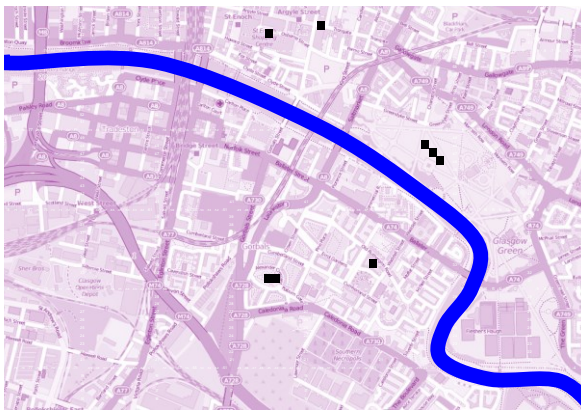
Figure 5 is a simplified version of an A2 sized Submap which is used to collect data for surveying the fifteen different elements of lived spaces illustrated in Table 1. Four scales (local, city, national and global) are included in four different quadrants (Fig. 6) of a 2D Cartesian plane in which one unit is 16 pixel. A grid of 16X16 pixel is overlayed on the Cartesian plane; through this simple manipulation, it becomes possible to collect, digitize and represent in one single database spatial datasets existing at different scales by using a grid

system. Open street data is used for the background maps at different scales. Figure 6 gives a better idea of the layout of the different scales in the four different quadrants of the Submap. Each 16x16 cell is defined by two integers following a Cartesian Coordinate system. The 16 pixel unit was carefully selected in reference to the size of the Submap in order to ensure that one cell could locate states in the global map and identify buildings in the local map. By using this system privacy issues are addressed as well. The choice of the paper size was influenced by the need of moving beyond the constraint provided by the size of common desktop screens limiting sense making activities to the common practice of zooming in and zooming out different scales denying the possibility of relating different scales simultaneously and improving sense making activities. On the sides of the A2 sized Submap in Fig. 6, two boxes are used to collect spatio-temporal data (e.g. residential history since birth, willingness to move and time spent out of neighborhood and out of city). Fig. 7 is an example of an 'extended mapping' developed for the representation of space-time fields for different subjects.

These illustrations represent a proof of concept and their aim is to conceptualize and refine existing map design and test a surveying procedure for a community mapping strategy. Although only three people were surveyed in a Park in the Gorbals (demonstrating some limitations of outdoor surveying), it is possible to observe similarities and differences in spatial perception and utilization patterns between these three individuals. Moreover, Submap includes demographic questions pooled from National Surveys such as the Household Survey to explore whether patterns vary between different spatial and/or demographic variables.

For example, if we consider the three space-time fields in Fig. 5 it is possible to speculate areal size of perceived neighborhood to the different space time fields in Fig. 7.

Door to door digital mapping is not seen as a feasible method for lack of resources and time but its advantages in collecting a more representative sample and improve the efficacy of the digitization process is recognized. Other feasible methods (Community groups meeting, postal surveys and door to door surveying) are used to create a *Gorbals's Submap series* which will include a selection of visual displays similar to the ones presented in this paper composed by four A1 paper (4xA2 Submaps). This series will be showed to different communities of practices in order to determine whether users find these maps useful and informative which is the final step of cartographic design process (Slocum et al. 2014).



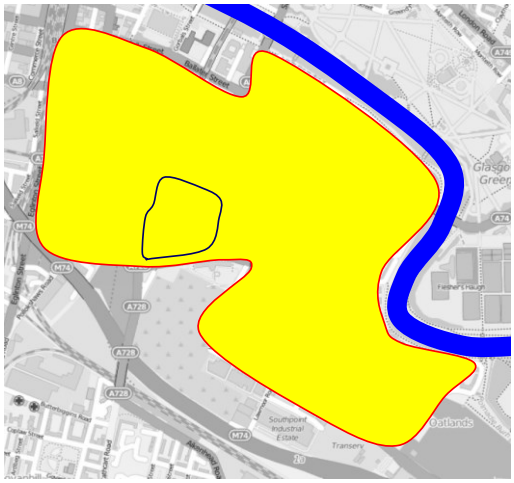


Fig. 1 (On the left) 'Myplaces' at local: cumulative for three Authors ; Figure 2 (on the right) My neighbourhood" for three different Authors. Both are snapshots from Fourth Quadrant in the Cartesian plane (map size A4; 4xA4=A2).

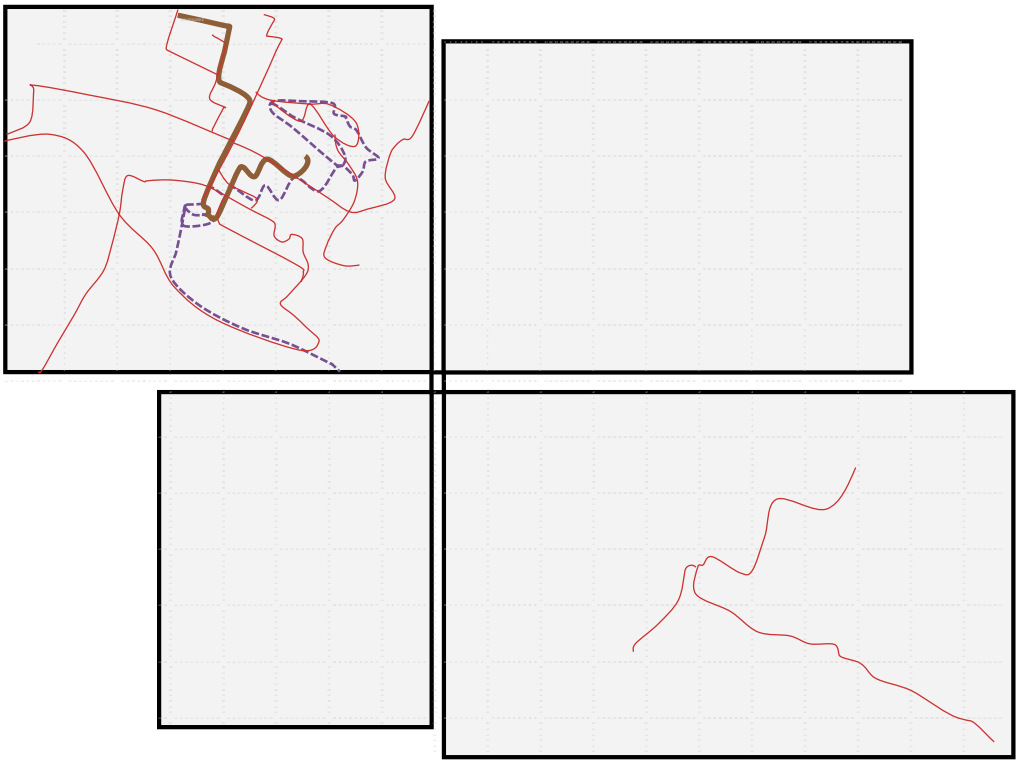


Figure 3 "My routes" in one typical week for three different Authors distinguished by different graphic devices (A2 paper)

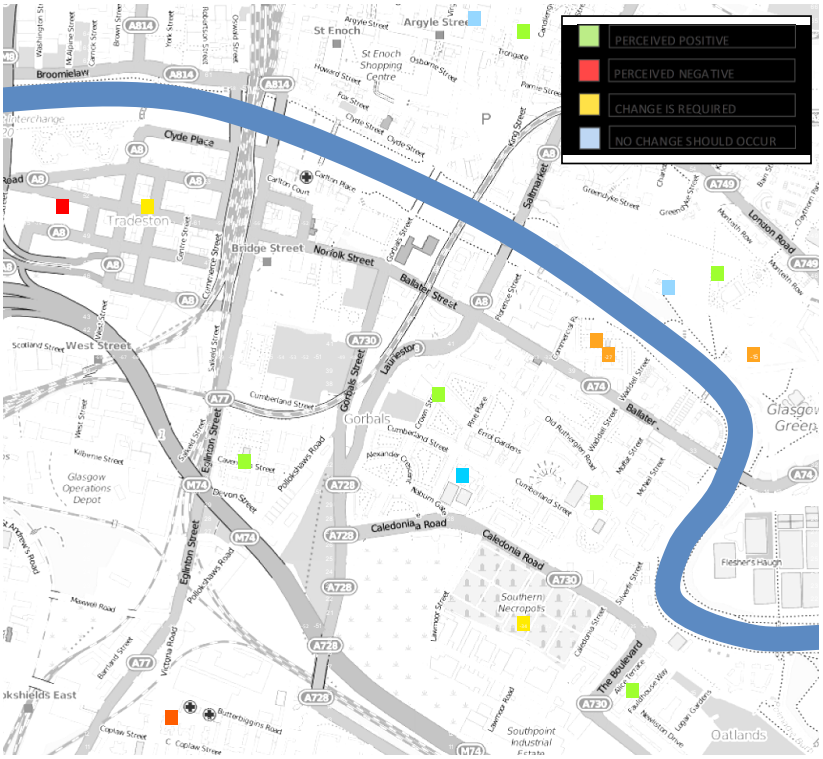


Figure 4: Perceived changes (for all authors)

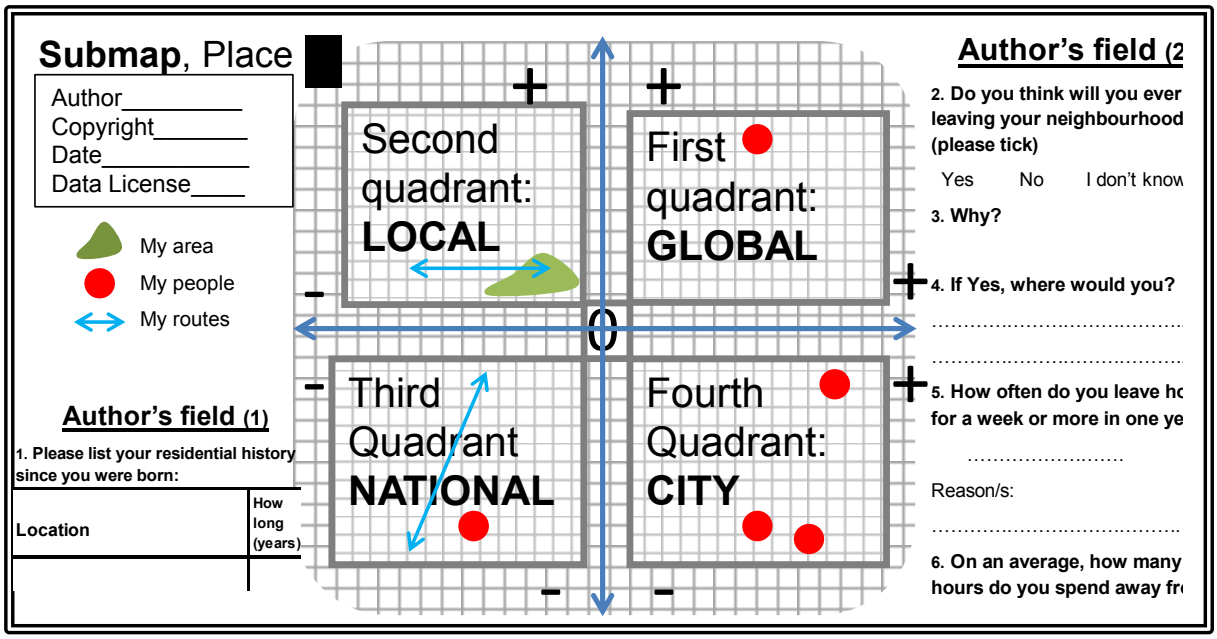


Figure 5: 'Submap': elements and simplified layout (original size is A2)

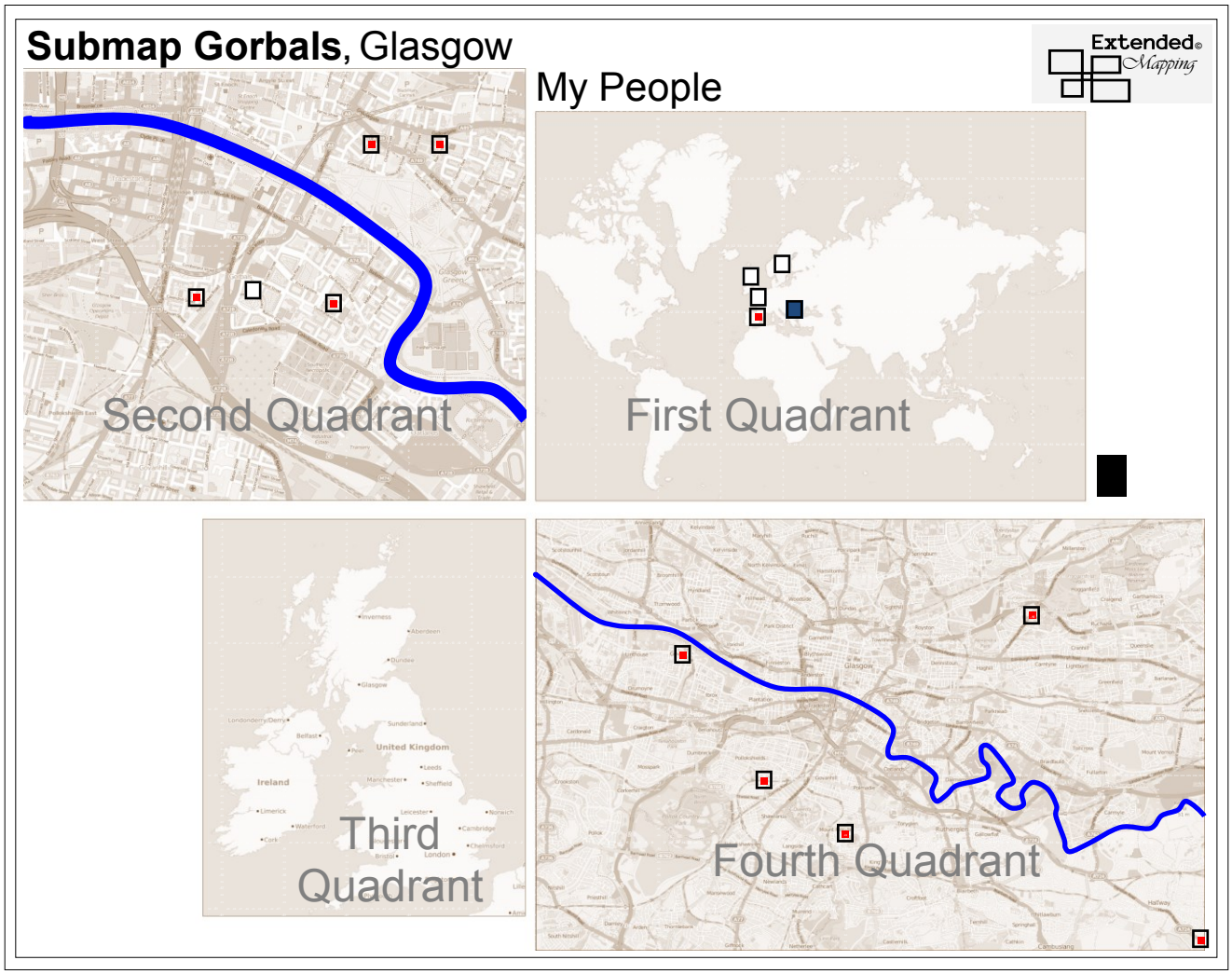


Fig.6 'My people' Submap showing the location of kinships at different scale for three different authors

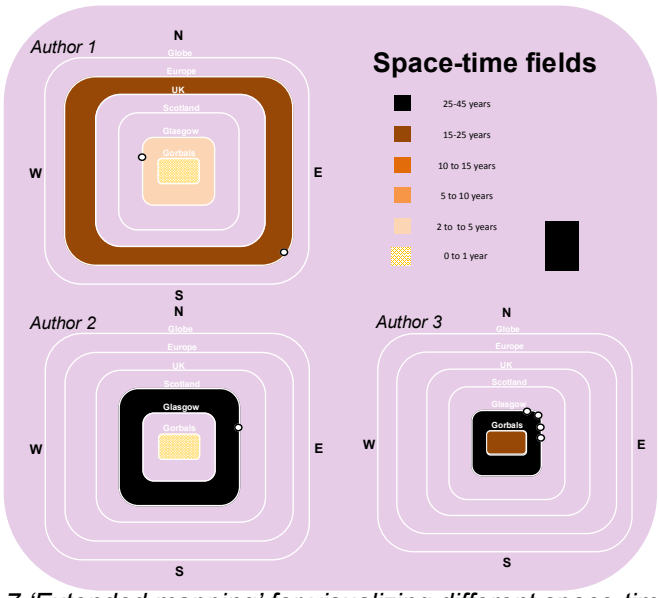


Fig. 7 'Extended mapping' for visualizing different space-time fields for different authors using residential history (from birth)

5 Conclusions and future research: A relational database for inclusive area profiling

Author ID	Age	Ethnicity	Income	Housing	Disability	Spacetime ID
1	35	White	a	flat	yes	1
2	22	White	b	mansion	no	2
3	57	Asian	c	flat	no	3
...	...	...	...	...	...	...

Space time ID	0 to 1	2 to 5	5 to 15	15 to 25
1	26,78	26,145	45,78	0
2	0	0	-73,-56	-96,89
3	0	-100,136	0	-100,136
...	...	...	...	...

Entity	x,y	AuthorID	Field	Date	Datazone ID
00260078-000	26,78	1	Positive change	05/06/2015	SP140430
0-730-56-000	-73,-56	2	Home	05/06/2015	SP140430
-1000136-000	-100,136	3	My people	05/06/2015	SP140431
...	...	...	...	...	...

Datazone ID	Population	% Unemployed	% Asian	% Council Tax A	% Disability	% Benefit	PM12	Derelict (m2)	...
SP140430	3621	20	a	12	52	1	3.5	37	...
SP140430	2500	19	b	12	40	2	0.12	0	...
SP140431	751	4	c	45	14	3	0.01	0	...
...	...	...	...	...	...	...		..	...

Figure 8 : An hypothetical relational database for collaborative planning including subjective lived space

In Figure 8 an hypothetical relational database for GIS able to retrieve and represent both relational and non-relational spatial data is presented. This conceptual modeling is based on the idea of relating subjective mappings to demographic profiles and datazones. An important requirement of this relational database is the one of 'interoperability' between quantitative and qualitative spatial data. Submaps have been designed with this in mind by overlaying a grid system to a two dimensional Cartesian plane. Every cell in the grid system is given unique coordinates while being associated to a datazone and every spatial entity mapped by any author is instead associated to a cell in the grid system. In order to avoid replication of data, every spatial entity mapped by every subject is uniquely identified by a 12 digits code in which the first six digits are used for including the coordinates of specific spatial entities and the last three digits for numbering each entity uniquely. By relating these two datasets, Geographic Information Systems can store and retrieve quantitative and qualitative spatial data opening up new avenues for area profiling and monitoring which have not been explored before. More importantly, the symbolic inclusion of subjects in subject-free database is seen as a step towards the consideration of the paradox of 'control and collaboration' in planning.

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