Spatial knowledge management tools in urban development

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N-AERUS XI
URBAN KNOWLEDGE in CITIES OF THE SOUTH

Abstract

Different forms of spatial knowledge (expert, tacit, sector and community knowledge) are a strategic resource in urban development. Research methods concerning participatory data collection and analysis that elicit and integrate the various forms of knowledge or co-produce knowledge through collaboration between scholars and practitioners have the potential to inform local action and public policy.

Recent developments in the (geo)information technology and data collection tools have extended the opportunities for spatial knowledge production, use and exchange. Such technical advances have the potential to both enhance wider access and understanding as well as to result in more exclusive processes. Although such tools have generally been the preserve of professionals there are increasing examples which suggest they might offer some inclusionary benefits like the case of the collaborative Map Kibera project (http://www.mapkiberaproject.org/) in which a digital geo-referenced database of physical and socio-demographic database of an informal settlement is created and shared, or the provision of and access to user-generated data on Google Earth and Google Maps. While technology opens up new avenues for knowledge management, data reliability and the type of knowledge transmitted will become a pressing issue due to the open access to internet platforms and lack of control concerning user-generated information and reference data.

We start the paper with a theoretical discussion on knowledge management models, followed by a review of available tools for the production, use and exchange of various forms of knowledge. Building on the review and examples of our own work in Asia, Africa, and Latin America, we highlight key challenges, added value and its limitations in urban development. We argue that although much progress has happened, development of technology and new tools alone is not able to fully address key issues regarding greater accountability, empowerment, production, control and use of information. These developments may also foster social exclusion, which could hinder greater benefits of participatory spatial knowledge management in the context of urban sustainability.

1. Introduction

The emergence and growth of urban areas can be seen as the consequence of a nodal development of many different processes, actors and organizations, and flows of goods, services and knowledge. Simultaneously, urban areas are places, which provide their residents with a certain quality of life in terms of housing, services, employment and consumption. This complexity makes spatial knowledge and exchange of knowledge in various forms an essential process in urban areas in order to move towards more equitable and economically and ecologically resilient development processes. Spatial knowledge can be defined as i) a set of information that refers to a geographical location on the globe (geo-coded or geo-referenced data; a place, a road, or an area); or ii) as a more holistic and perceived spatial “comprehension” of facts, interdependences, connections and dynamics that can be mapped; either individually conceived or shared by a group. It exists in various forms; expert, sectoral, community and tacit knowledge are often distinguished (van Ewijk *et al.*, 2009). Expert knowledge stems from the accepted expertise from professional education and professional organizations and is usually dominant in urban planning. Sectoral expertise is knowledge derived from practice, built up by professionals and practitioners in their working situation. Community knowledge is the knowledge about their spatial surroundings, political and social situations of residents in any given area, and tacit knowledge is that which is 'known' by either communities or professionals, but seldom put on paper, and quite often ignored in urban development processes (Rip, 2001; van Ewijk *et al.*, 2009). The questions raised in this paper concern how the value of these different types of knowledge can be more explicitly recognized in urban development processes, how they can be produced and exchanged with potential greater effectiveness.

A major method of making various types of knowledge more visible and providing a platform for knowledge integration is through *participatory spatial knowledge* production and exchange linked to each other by a form of geographical information system (GIS), which links different types of knowledge to one locality. This can include qualitative community-based information; it can include information on the infrastructure from the municipality, or housing patterns from the cadastre. The goal of such spatial knowledge production should be to include the (1) various kinds of knowledge into a recognized and commonly held set of knowledge, so that all actors are equally included in its production and exchange (e.g. Joshi *et al.*, 2002). The (2) participatory processes involved are necessary to bring out the various types of knowledge, which are usually not laid down in written form: tacit, community-based knowledge, and sectoral knowledge related to practice, as well as to include actors who are usually excluded. The (3) geographical information systems linking knowledge to one area visualize the various types of knowledge and makes exchange on priorities, conflicts and synergies more explicit.

Therefore, this paper discusses (1) actors and their knowledge types, and (2) (participatory) spatial knowledge management tools, based on geographical information technology (GIT), which make the production, use and exchange of knowledge potentially feasible. This will provide a heuristic model for assessing the extent to which (participatory) spatial knowledge management tools can provide means for more inclusion, empowerment and accountability in urban development processes and the risks that might be associated with such tools. This research is carried out within the research programme *Chance2Sustain*[1].

2. Production, exchange and application of spatial knowledge

Participatory spatial knowledge is the main concept we use to study the issue of urban sustainable development, as it reflects a strategic resource, to which all stakeholders can contribute in urban governance. It includes expert knowledge and several forms of non-expert knowledge, such as knowledge from experience (tacit), embedded environmental and economic sector knowledge, and social knowledge at the neighbourhood and citywide level (Coaffee *et al.*, 2003; Bruckmeijer *et al.*, 2008; van Ewijk *et al.*, 2009).

Policy making increasingly takes place through networks of actors which are "relatively stable sets of independent, but operationally autonomous and negotiating actors, focused on joint problem solving" (Hajer, 2003). These actors include the state,

1 The full title of this Research Programme is 'Urban Chances - City growth and the sustainability challenge. Comparing fast growing cities in growing economies', funded under the 7th EU-framework programme (Project no. 244828). Partners in this programme are the European Association of Development Research and Training Germany; Amsterdam Institute of Social Science Research University of Amsterdam (The Netherlands); French National Center for Scientific Research (CNRS) France; School of Planning and Architecture (SPA) India; Cities for Life Forum (FORO) Peru; Centro Brasileiro de Análise e Planejamento (CEBRAP) Brazil; Norwegian Institute for Urban and Regional Research (NIBR), Norway and the University of KwaZulu-Natal (UKZN) South Africa. For more information on the research programme see: http://www.chance2sustain.eu/

NGOs, business, consultants, scientists and civil society. Participatory processes within urban planning and management are strategic in eliciting forms of sector- and location-specific knowledge, which are usually not acknowledged in top-down, expert-driven models of urban governance and planning. Incorporating both expert and local community knowledge in participatory spatial knowledge management can make urban governance and planning potentially more effective and socially acceptable (Innes *et al.*, 2005).

Theorists have also examined the extent to which civil society is 'included' or 'excluded' from the state in the process of policy-making (Bulkeley, 2000; Young, 2001; Yanow, 2003). The degree of 'inclusion' in deliberative forums and governance structures is not the only measure of democratisation. Recent work has focused on the dynamics between such 'inclusion' in decision-making processes and oppositional activism which shapes the form of democratic opposition (Scott *et al.*, 2008). Young examines the relationship between deliberation and activism concluding that both have the potential to deepen democracy and increase sustainability. A characteristic of urban governance in the network society is the multi-vocality of the views expressed by the range of stakeholders participating in the decision-making, each 'voice' providing a different perspective and meaning attached to the issue, i.e. different 'knowledges (Hajer *et al.*, 2003). (Laws *et al.*, 2003) use the concept of 'framing' to conceptualise how stakeholders create a framing discourse or 'knowledge' that gives meaning to their experience of policy issues. With the wide range of stakeholders taking part in urban policy making, 'difference' becomes very important as the myth of absolute knowledge is exploded and a need arises to take cognizance of the variety of discourses actors adopt to make sense of their experiences (Yanow, 2003).

In the network society, with increased public participation in decision-making, the power of expert scientific and lay knowledge has shifted. In contemporary society, where 'hard decisions' have to be made hurriedly with only 'soft' evidence, the role of expert scientific knowledge in decision-making has been challenged. An increasing mistrust of science and a call for local knowledge in policy making is made (Hajer, 1995; Fischer, 2003; Hajer, 2003; Yanow, 2003; Scott *et al.*, 2008). Citizens are becoming aware of the failure of science and expert knowledge applied by the state to address contemporary environmental and social problems, and unease and anxiety in society has been brought about by the 'democratisation of knowledge' (Hajer *et al.*, 2003). Hajer (1995) therefore points to the importance of 'socially acceptable science' in democratic environmental governance.

When we look at the issue of processes of knowledge-building linked to different forms of knowledge, two basic approaches are found. The first concerns the classic mode I knowledge-building process, related to notions of knowledge as scientific codified knowledge, built up in linear processes of experimentation, verification and codification (Gibbons *et al.*, 1994), or what Bruckmeijer and Tovey (2008) call the 'elitist model'. The knowledge-building process relies heavily on expert and scientific knowledge system, and formulation of 'the problem of sustainable development (SD)' and paradigms are heavily dominated by scientific and bureaucratic establishments. The second model, mode II (Gibbons *et al.*, 1994; Rip, 2001), distinguishes different types of knowledge (tacit, practice-based, scientific) and recognizes knowledge building as a social process, in which various paradigms compete with each other through institutions, and the sources of knowledge come from scientists, working experiences and community-based knowledge of various groups. Bruckmeijer and Tovey (2008) distinguish two variants in this mode – the 'incorporation of knowledge' model and the 'knowledge embedding' model. In the first model, practice-based knowledge is also included in knowledge-building, particularly by local producers. The second is based on the idea that knowledge processes are built up through social institutions, power struggles between groups for recognition of their definitions of problems in a conflict-prone process.

Bruckmeijer and Tovey (2008) have developed a third model, from their studies of sustainable rural management or SRM in Europe; it is a bottom-up model based on contextual knowledge – i.e. where the knowledge for a particular view of SD is generated, codified, disseminated, applied and its level of success evaluated.

A final issue in knowledge generation models is the contesting of 'official' knowledge (spatial knowledge as challenging knowledge), when expert, techno-administrative-legal hegemonic knowledge is contested or disputed by 'civil society' (like activists producing, in court or in NGO report/media, alternative evaluation of land use or land fertility to oppose public/private land acquisition using Google-Earth imageries). The use of spatial knowledge cannot be reduced to participation, as in many situations even low levels of participation are denied. It is also a knowledge that has to be used to resist and develop counter arguments. The present democratization of mapping tools and spatial information is fundamental to this process (counter-mapping).

In the cases presented in section 4 we will provide some examples of spatial knowledge types, production and exchange, from our own experiences, in the light of the various knowledge models.

3. Available tools of spatial knowledge production, use and exchange

Geographical information technology (GIT) provides tools for spatial knowledge production, use and exchange to support sustainable urban development. Examples are geographical information systems (GIS), earth observation/remote sensing (RS), global positioning systems (GPS) or other mobile devices and web-services making use of GIS functionality and GIS data and/or remote sensing data, such as mobile GIS, GPS navigation or Google Maps and Google Earth. These tools facilitate spatial data collection, management, processing, analysis and visualization.

In the early beginning of GIScience, the use of GIT was limited to specialists who had particular technical skills and interest in the production of technical spatial knowledge. In this field, information derived from GIS and RS data is often considered a standardizable, formal, quantitative, mediator of spatial knowledge (Georgiadou *et al.*, 2010). In contrast to this approach, a ´new´ field arose from social scientists, labelled by many as critical GIS or ´GISocial´, in which GIT-based knowledge to ´democratize´ marginalized or disadvantaged groups is questioned (Elwood, 2006; Dunn, 2007). In GIS, for example, we try to squeeze the reality on the ground into points, lines, regions, grid cells and categories, but the choice of boundaries or codes may have adverse effects on representation of particular groups.

Parallel to the emerging critical perspectives on GIT, spatial knowledge production, use and exchange are becoming daily practices for lay people, provided they have *access to internet*. This development is stimulated by the more user friendly desktop GIS and RS software, the commercialization of GPS receivers and navigation, the 'easy' access to exclusive spatial through Google maps, Google Earth and other GIS-based web services as well as the awareness of location, expressed in GPS co-ordinates, a feature in mobile phones, cameras and other mobile devices. Especially the latter resulted in the new field of volunteered geographical information or neo-geography (VGI) emerging in GIScience, (e.g. Goodchild, 2007; Elwood, 2008; Foth *et al.*, 2009). This builds on the knowledge produced, exchanged and consumed by lay people. Free Internet tools have opened the eyes of millions to the possibilities of digital geography (Butler, 2006). However, not everybody has access to internet and broadband connection (Poorthuis, 2010).

The spatial dimension and GIT is being discovered by many disciplines, such as public administration, epidemiology, criminology, forensic science, anthropology or archeology. Both the commercial sector and government agencies employ GIT to increase efficiency. For example, GIS analyses are used to find suitable locations for new shops; government departments are obliged to digitize and standardize their data and maps to facilitate the sharing of expensive GIS-data and make their data compatible; and emergency services use GPS navigation and spatial data infrastructures for disaster management.

The horizontal and vertical shift of GIT (specifically the adoption of GIT methods by other disciplines and the emergence of the GIS amateurs) creates a diverse range of spatial knowledge sources. However, these may be fragmented across different actors and platforms, address different spatial scales and refer to different moments in times, regulations concerning access and use, and vary in terms of reliability, accuracy and completeness. Various knowledge types may empower and marginalize people, as well as increase internal efficiency in organisations, and increase spatial inequalities. Hence, bringing together the diversity of spatial knowledge sources for sustainable urban management poses a particular challenge for (participatory) spatial knowledge management. A particular issue is how to build consensus regarding the presentation and mapping of shared spatial knowledge as well as in analysing spatial knowledge. To better understand the complexity of this issue we will discuss the diversity of knowledge sources, and methods and tools to use, produce and exchange spatial knowledge.

GIS/RS data

Conventional sources for technical knowledge about the urban environment are GIS and remote sensing data. Typical GIS layers are property tax parcels, infrastructure maps for roads, water and sewage, drainage system, land use maps, administrative boundary maps to which socio-economic data can be matched and point maps displaying geographical locations of basic facilities or other points of local interests. During fieldwork in Indian cities we noticed that high priority is given to the digitization of property tax databases to increase efficiency and tax revenues, while little expertise and capacity was present for handling and analysing geographical data sources, although these could be used effectively in monitoring spatial inequality (Martínez, 2009) and urban governance (Baud *et al.*, 2008). At the same time certain GIS databases were created by private firms which advertised detailed data layers for high prices, but are little accessible for researchers and public administration. Nevertheless, relying on regular GIS data only is also problematic, because the data can only show what has been put in, and this technical knowledge is often considered the truth as it can be quantified. Certain areas (and people) within a city are 'switched-off' or even rubbed out and erased by the process of digitization (e.g. in digital cadastres (c.f. Benjamin *et al.*, 2007)) or do not exist because they are not included in the database (e.g. an illegal settlement on *poramboke* land that does not appear in the master plan (Chennai 2025)) and therefore these areas and people are excluded from decisions based on technical knowledge only. Additional knowledge sources need to be included to also recognize excluded areas and groups.

The other technical data source is remotely sensed data, specifically satellite images and aerial photographs. Detailed spatial and temporal information on the urban environment can be derived from very high resolution images like Quickbird, Cartosat or Ikonos. Although such images are already very interesting in themselves (with the launch of Google Earth millions of people located their own house), their strength lies in the combination with qualitative data sources. In order to systematically derive spatial knowledge from such images it is important to know how the displayed information can be interpreted and codified, i.e. whether it is possible to delineate and label areas on the basis of physical characteristics. Sliuzas (2004) and Lemma et al. (2007) have applied a participatory approach to delineate slum settlements in African cities whereby citizens created the physical criteria of what would determine a slum in the local context, and Baud et al. (2010) have used visual image interpretation to delineate sub-standard housing areas in combination with semi-structured field-surveys and qualitative interviews. To use the rich information provided by remote sensing images more effectively, one needs to include various knowledge sources for defining and delineating objects (a researcher might interpret differently than a local) and take into account temporal references in the visual interpretation.

Spatial data infrastructures

With the increasing use of digital data production and use in various government sectors various forms of spatial data infrastructures (SDI) were created to support sharing and accessibility of expensive geo-data collected by different agencies. This could reduce costs of data production, and eliminate duplication of data acquisition efforts (Crompvoets *et al.*, 2007). In the past decades several SDIs have been developed, often top-down focusing at standards and interoperability rather than on the resources, and practices and needs on the ground. In India, for instance, several SDIs are constructed at local (e.g. Delhi SDI), state (e.g. Karnataka SDI) and National levels, but little evidence is available regarding their harmonization, or impact on planning and decision-making processes. However, the basic concept of SDI in terms of sharing is a useful framework for spatial knowledge management.

PGIS

As GIS began to play an increasing role (in the mid-1990s) in decision-making and democracy generally, academics, planners and community organizers started to improve access to GIS, for those who were under-represented in decision-making processes (Obermeyer, 1998). Driven by critical attitudes towards GIT, but also to complement technical knowledge, participatory GIS approaches were established. Sieber (2006) identified various versions of participatory GIS in practice. A first approach consists of GIS utilization and associated training for communities to be able to apply GIS in their daily practices. Another common approach in developing countries is the participation in inputs and outputs, i.e. contributing to the production of spatial knowledge and verifying outcomes. Originally this was mainly applied in natural resource management (see e.g. Craig *et al.*, 2002; Sydenstricker-Neto *et al.*, 2004), but has also been applied in the urban context (Sliuzas, 2004; Pfeffer *et al.*, 2010). A further PGIS approach, referred to community mapping, focuses on the production of knowledge to empower communities, to make their voice heard and to reach the hard-to-reach (see e.g. Joshi *et al.*, 2002; Hoyt, 2005; Cinderby, 2010). A special participatory GIS approach is the Kibera project in Nairobi, Kenya (c.f. http://www.mapkibera.org), where collaborative efforts of technical volunteers and community members resulted in digital databases for 13 villages which would be a blank spot on the map otherwise, using mainly open source software. With the move towards more participatory urban planning and decision-making, the term public participation GIS (PPGIS) evolved, emphasizing the input of the public in planning and decision-making processes (see e.g. (Schlossberg *et al.*, 2005)). This has for example been implemented by providing an interface, often in the form of a webpage with GIS functionality (e.g. Kingston, 2007), for facilitating information exchange or one-directional provision of information

VGI/neo-geography

With the increasing awareness of location, data-sharing and open source software, increase in internet access and onset of new technologies, a lot of spatial data are created, changed, assembled, and disseminated on a voluntary basis by GIT amateurs (Goodchild, 2007). A well-known example of open source data generation is the open street map or wikimapia, where spatial data can be created, changed and used by anyone. Such volunteer effors can potentially fill a gap in the availability of digital geographical information, especially in developing countries where spatial data are still scarce. This ‘new’ knowledge and technology provides new ways of using and interacting with GIT, and new opportunities for creative knowledge management in urban development, but is an extra challenge to the ‘reliability’ of the knowledge and inclusion of groups who are ‘excluded’. GPS co-ordinates and trajectories, geo-visualisation and mash-up facilities receive particular attention. For example easy-to-use virtual globes can facilitate spatial information communication between stakeholders and government agencies. The role of the GIT expert may shift from producer and user to guide and facilitator of knowledge production, use and exchange. VGI is a new direction of research, and the implications of these knowledge sources for development need further investigation. It can also be an important aspect in knowledge infrastructures as network (of human sensors), acting independently and responding to needs of local communities, can together create a patchwork coverage.

The selected review provides a snapshot of the diversity of knowledge sources and tools, ranging from the technical knowledge derived from GIS and remote sensing data to qualitative community knowledge and voluntary participation in producing spatial knowledge and tools enabling knowledge sharing. Capturing and incorporating qualitative data into technical knowledge databases provides important contextual information which otherwise may be missing from the maps that are its ultimate outcome. The challenge is how to incorporate knowledge sources - ranging from volunteer efforts to being involved in the decision-making process - in a sound way and to translate qualitative knowledge into GIS as the language of planning and decision-making (Dennis, 2006). More than in any other form of knowledge production, spatial knowledge development and diffusion builds physical limits and borders have a strong effect on the reality reflected in maps. The map in turn becomes the reality; its borders are used for the dynamics of identification and differentiation, reflecting opposing group interests.

4. Cases

To demonstrate the applicability of spatial knowledge tools, we present experiences from our own work in Brazil, India and South Africa. The case in Brazil concerns the development of a digital database through participatory GIS for a community in Sao Paulo, in which teenagers are trained in data collection and digitization. The second case focuses on developing a web-mapping tool for Chennai in which public data are brought together with user-generated content using open-source software. The example from South Africa regards a community GIS system which graphically displayed the spatial distribution of community complaints, sources of air pollution, pollution incidents overlain over the residential landscape of the South Durban valley. Each case will be briefly introduced and then summarized in Table 1.

Brazil, Sao Paulo
An exciting experience with Participatory GIS is implemented by two NGOs in Sao Paulo, Brazil: *Instituto Lidas* and *Associacao Casa dos Meninos*. Instituto Lidas (www.lidas.org.br) emerged in the late 1980s within the labor movement in Sao Paulo. It focused its attention on producing data on factory working conditions and using this data for educating workers and supporting their struggles. Over the years this early interest was broadened with the development and increasing access to GIT, *Lidas* shifted its focus on mapping social equipment, basic infrastructure, and services for specific poor neighbourhoods. *Jardim Sao Luis* in the South of the municipality and home to the NGO *Casa dos Meninos* is one neighbourhood which has become a pilot area for various projects.

Casa dos Meninos was started by business people in the early 1960s as an orphanage for abandoned children. Over the decades, this NGO expanded its activities including today educational and cultural activities for juveniles living in *Jardim Sao Luis*. A common commitment to social promotion and inclusiveness has brought these two NGOs together. Since the early 2000s, *Lidas* and *Casa dos Meninos* have been partners in GIS projects involving training youth in GIS, creating public databases, and data collection. The broader goal of this partnership is to collect and digitize spatial information concerning the neighbourhood and make this information available to larger audiences to educate and inform individuals so community members can act and make a difference in their neighbourhood.

Early work in 2001 included gathering public data on various social indicators (education, employment, wealth, number of children) as well as on location of schools, health posts, NGS, churches, firms, in the neighborhood. Interns from *Casa dos Meninos* collected the data in area near their houses. All the data was incorporated into a GIS system and various maps of the community were produced. This process not only produced a wealth of information available to a larger audience. Most importantly, this process triggered a sense of better understanding of and belonging to the neighbourhood. In addition, access to information allowed citizens to place their own neighbourhood vis-à-vis other neighbourhoods and the municipality at large.

This early work evolved to specific projects. One major area *Lidas* and *Casa dos Meninos* have worked on together is on issues related to social conditions and rights of children and youth. In response to a request from the Sao Paulo Municipal Council for Children and Adolescent Rights, *Lidas* developed a system for easy access of indicators on conditions of children and teenagers in the city of Sao Paulo (http://www.criancaeadolescente2007.com.br/modulo/index.htm). Various indicators covering demographic, social, health and economic conditions can be plotted at various scales (municipality, district, sub-district, etc.). An expansion of this project is a complete mapping of public services (daycares, schools, health posts, social services) including areas of high social vulnerability and children out of school. A pilot project has been completed for the M'Boi Mirim District (http://www.conferenciadedireitos.org.br/sua-regiao.php). This pilot project is also part of a broader initiative for developing instruments for planning at the district level. Although not yet implemented, project coordinators plan to use i3Geo (http://www.baixaki.com.br/download/i3geo.htm) mapping tools based on the MapServer (http://mapserver.org/) open source platform for publishing spatial data and interactive mapping applications to the web.

The usefulness of all the work these groups have put together and the potential of those efforts in informing urban planning and supporting social movements' demands is clear; they are concrete cases in which the mapping system itself could leverage broader causes, support explicitly oriented action, and inform orchestrated planning. The question is how to scale up and maintain these efforts at the city level. The scarcity of such cases might be well connected to limited resources, NGO experiences and institutional gaps in making it possible to have a continuous program over some years.

India, Chennai
Transparent Chennai (http://www.transparentchennai.com) is an interactive web-mapping initiative that has been developed since 2009 by a Center for Development Finance team supported by local, national and foreign experts and activists. The Centre for Development Finance is a non-profit action research think tank, founded in 2006, focusing on improving government systems and market capacity to channel finance into sustainable and holistic development[2]. The aim of the interactive website is to provide useful and easy to understand information about Chennai that can improve government accountability and empower residents to take action (http://www.ifmr-cdf.in). The website has been created with support from Google.org (Tide Foundation) under the *Inform and Empower* Initiative and a grant of the ICICI Foundation for Inclusive Growth. The Center for Development Finance is developing other interactive web-mapping tools under the banner of *Visualizing Development* in India concerning pollution, education, governance and MDG indicators.

Transparent Chennai provides geographical and geo-localized information organized by thematic layers[3] about Chennai that can support the understanding of local

2 It is affiliated with the Institute for Financial Management and Research (IFMR) of Chennai, established in 1970 jointly by ICICI bank, the House of Kotharis and other major industrial groups and lead by a city planner by training.

3 Current layers are roads, administrative boundaries, census 2001 data by wards and major public facilities, stratum documenting slums locations, slum evictions, public toilets, public investments like flyovers, expressway and bridges (investments, expected duration, delays etc). Spatial information about environmental sensitive areas, metro and bus lines, garbage dumping sites (approved and illegal), trees at the neighbourhood level, water bodies, tanks and reservoirs (including encroached ones since the 1950) is in the making and planned

needs, and also a tool to evaluate government performances and program choices, efficiency and accountability. Using Google map tools has advantages: first, the mapping interface does not restrict the extent of maps to the city itself like districts, wards, *taluks* and villages boundaries (ie. data do not stop at the border), but makes it possible to view generally available data, like road networks, public facilities and landmarks for a larger area like the Chennai Metropolitan Development Authority area. It reflects the idea of an extended Chennai and the reality of the urban region. Local administrative boundaries are given with a list of official contacts at each level, working like a gazetteer for accessing persons in charge. Second, the tool is interactive. It means that individuals and groups can enter their own information that will appear after moderation by a webmaster. Users are encouraged to create and submit their own data about the city and to correct the basic information provided by the team behind the project. There are also plans that users will be able to upload photographs, opinions, and information about places and projects in the city to specific layers from mobile phones[4]. For instance, citizens are invited to help map the bus network[5] by riding the bus with a GPS unit or marking familiar routes.

Transparent Chennai was launched in 2010 and promoted in the context of the MapIndia conference, the World Habitat Day and the 2010 celebrations in Madras University. To date, the initiative has found many users and interests among civil society and local NGOs. Information is accumulating quickly and new thematic layers are created like for instance the geo-census of public toilets. However, *Transparent Chennai* is not yet really expanding with the support of individuals and ordinary citizens reporting information, but much more by local NGOs or branches of national NGOs. For instance, *Civic Exnora* at the street level and *Exnora Innovators Club* volunteer to add their expertise in identifying the location of dumping sites. *Civic Exnora* works with Residents Welfare Associations. *Penn Urimai Iyakkam*, a women's liberation organization, helps *Transparent Chennai* volunteers to inventory the slum evictions in Greater Chennai. *Nezhal* supports the trees layer development based on the tree census. *Transparent Chennai* also conceives its action in the frame of the Right of Information Act, 2005, that authorizes any Indian citizen to legally question public action. In that perspective, *Transparent Chennai* is assembling maps and public reports concerning Greater Chennai and works hand in hand with a Tamil NGO promoting the use of the RTI Act. Its campaigning found recognition in local newspapers.

Transparent Chennai is still limited as a tool of empowerment. It is obviously a shared tool between IT experts and NGOs oriented to a segment of the web-connected middle class more than the ordinary or poor citizen. Its potential for inclusion, sharing expertise and monitoring can, under certain conditions, become a strategy of control. It can, for instance, serve to reinforce the local Residents Welfare Associations in their actions to control the quality and value of their area by excluding the poor. Nevertheless, India has already a long experience of internet mobilization and extending local controversial issues to a national and international audience, for popular mobilization. Clearly, such kinds of tools have the power to highlight local claims, and monitor public as private actions locally, but may ignore what is not in the digital database.

South Africa, Durban

In the South African context, social issues are marginalized and local knowledge devalued in environmental and planning governance system in the post-apartheid period (e.g. Oelofse, 2009). Official policy interventions need to be backed up by scientific evidence - science based policymaking (Eden, 1998; Fischer, 2003). Therefore, the oppositional politics of civil society in South Africa have had to present their alternative societal visions framed in a scientific discourse (Scott *et al.*, 2008). 'Civic science' is a form of knowledge used by communities in the ''struggle over facts and science" (Brown, 1997, 143). Scott and Barnett (2008) show the importance

to be added.

4 The mobile mapping technology will apply authorizing instant (real-time mapping) diffusion online with the geo-localization of updates about new services, accidents, crimes, sitting contestations, pollutions etc.

5 There is no map of the Greater Chennai bus network, not even in paper format.

of ‘Civic science’ in civil society organisations as they challenge the rejection of the validity of their lay knowledge in deliberative forums (c.f. WYNNE, 1996). In this way, civic science is viewed as a “strategic resource for environmental justice movements in South Africa”(SCOTT *et al.*, 2008, 375). ‘Civic science’ is defined here as “the production of knowledge by lay communities which claims to be framed within scientific methodology”. The South Durban Community Environmental Alliance (SDCEA) is a civil society organisation which has mobilised against industry and the state because of the impact of air pollution from heavy industry and two refineries on resident communities. Finding that their experiential and narrative knowledge of respiratory illness and cancer among residents in South Durban were not accepted as valid knowledge, SDCEA set about to create their own ‘civic science’ to represent and argue their position. ‘Civic science’ in this case consisted of a community GIS system which graphically displayed the spatial distribution of community complaints, sources of air pollution, pollution incidents overlain over the residential landscape of the South Durban valley. Other studies were commissioned by SDCEA using donor funding, to compare Danish and South African refineries in terms of the quality of their technology to reduce air pollution; the independent analysis of samples of air adjacent to the ENGEN refinery (the Bucket Brigade); and the production of a school textbook on meteorology and air pollution based on the South Durban case (Barnett and Scott, 2008). This scientific knowledge is used opportunistically with local experiential knowledge in opposition to official knowledge in policy making processes, or in activist events. SDCEA’s strategic sourcing and use of knowledge has contributed to their success in getting national and local government to engage in a participatory process, the ‘Multi-Point Plan, to improve the air quality in South Durban.

Table 1: Summary of the presented cases

Characteristics of Cases	**Brazil**	**India**	**South Africa**
Type of Organizations in Charge	Grassroots NGOs connected to social movements (labour union and neigh-bourhood association)	Non-profit action research think tank connected to the financial sector	By civil society, with donor funding, used for advocacy and activism
City	Sao Paulo	Chennai	Durban
Scale of Analysis	Municipal, District, Sub-district, Units of Participatory budget	Municipal or city level	Community level
Sources of Data	Mainly public data (census, national databases) but also own data gathering	Mainly public data (census, national databases) but also volunteer data gathering	Data generated with the help of citizens
Reliability and Validity of Data	Public Data – reliable within data limitations indicated by providers Own data – no information regarding methods for data collection and validity	Public Data – reliable within data limitations indicated by providers Interactive check of both public data and user-provided	Perceptions; difficult to measure in terms of reliability; Product of vision for a better life/attempt to provide ‘truth’ of the situation
Types of Knowledge	Codified, analytical-technical; Contextual - Embedded (technical, community based, political, and networks)	Codified; Analytical-technical; Un-codified (blog; photographs, etc)	Experiential ‘Civic Science’ GIS
Forms of Knowledge exchange	Top-down and Participatory	Top-down and volunteer effort	Deliberative processes, in the media, through activist performances
Actors Involved	Activist and Practitioners	Think tank; NGOs, CSO; volunteers	civil society, citizens
Potential Uses	Providing support for citizen’s and social movement demands	Kind of strategy of control	Inform local and national government about local issues
Degree of Empowerment	Has potential but not yet proved effective in a more general sense	Exclusive; directed towards the well-served.	Strategic use of ‘science’ to argue for social justice issues. Power through activist methods

5. Challenges for participatory spatial knowledge management

In this paper we have provided an overview of various dimensions of participatory spatial knowledge management; actors, knowledge production, exchange and use. The issue raised was the types of opportunities that participatory knowledge production, use and exchange provide in making urban decision-making more participatory, and inclusive in terms of the data generated and acknowledged. The assumption was that participatory GIT models can produce new knowledge, based on tacit, practice, and community knowledge, reflecting urban realities to a much greater degree. Potentially, this can make urban management and decision-making more inclusive and equitable.

The cases reflect this assumption top varying extents. In terms of actors, the cases illustrate the strength of NGOs and community volunteers in producing community-based knowledge. However, resource limitations prevent scaling-up knowledge production to the city-wide level. Cases provide only limited information on relations with the state and private sector. An exception is the Durban case where civic science was produced to counter local and state government inaction.

Concerning types of knowledge it is both technical knowledge, partly collected by volunteers (Sao Paulo; Chennai) as well as lay-based scientific knowledge (Durban). In all cases GIT plays a major role as a platform for knowledge production and exchange. Knowledge produced was visualized through (interactive) maps, more advanced in *Transparent Chennai*, more lay-based in Sao Paulo and Durban. To reduce the costs associated with GIT and to improve accessibility to spatial knowledge, open-source software was used.

On the one hand GIT provides many opportunities for both the production and exchange of technical knowledge as well as community knowledge. It facilitates the online access to and exchange of spatial data, as illustrated for the case of Chennai, online collaboration by providing individual knowledge and perceptions to platforms and participation in planning and decision making. This provides exciting opportunities for disseminating participatory mapping experiences and making their approaches and tools more accessible and affordable. However, issues of access to these tools and having the appropriate resources to keep up-to-date with new developments remain as a huge challenge for a significant portion of users.

The last dimension focused on the use of GIT models for more participatory and empowered public action and democratised decision making. The cases illustrate the increased awareness within local communities of the knowledge they possess and ability to contribute to decision-making processes on urban issues. This is mainly seen in the greater co-operation between government and NGOs to implement participatory processes and recognise local knowledge. Participatory spatial knowledge management could counteract some asymmetries inherent in formal urban spatial governance processes. One way could be that technical knowledge actually benefits from more fine-grained sourcing of data and setting up participatory spatial knowledge gathering exercises could help generate this; in *Transparent Chennai* users can for instance contribute to the improvement of available data layers; in this case it is volunteer participation. The second way is more transformative, in which dominant relations are challenged and value is attached to material generated that is balanced with spatial analysis and other GIT tools. Furthermore, participatory spatial knowledge management could seek to use the knowledge as a platform for action by participants to exercise influence in a direct way over how the spatial knowledge resources might be used.

However, it remains to be seen how strategic such knowledge can be in changing outcomes of urban decision-making. This constitutes our future research agenda of *chance2sustain*.

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