

Participatory 'Spatial' Knowledge Management Configurations in Metropolitan Governance Networks for SD

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THEMATIC REPORT

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Participatory 'Spatial' Knowledge Management Configurations in Metropolitan Governance Networks for SD

By Isa Baud, Karin Pfeffer, Dianne Scott, Eric Denis, John Sydenstricker



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1 Introduction

This report concerns the extent to which participatory spatialized knowledge construction[1] and learning are conducive to dealing with challenges of strategic domains of urban development; such as economic growth, reducing social inequalities and vulnerabilities, increasing environmental sustainability, and making use of decentralized and participatory fiscal flows. Our main idea is that spatial knowledge construction and use is a strategic instrument in urban development, making explicit the various types of knowledge existing in cities, and reflecting the priorities of different actors in the city (government, private sector and citizens). We focus on urban development processes in which various kinds of knowledge are produced, exchanged, contested and used, and the extent to which joint learning and collective local formulation of principles of change is generated by such processes.

Urban development processes reflect the dialectical relationship between society and space, as understood from the perspective of human geography. Specifically, space is socially produced but space and place act back on society and influence the structuring of society in a relational manner (Massey 2004; Peet, 1998). These dialectical relationships need to be explored in the processes of knowledge production and practices of urban planning and management so as to address the challenges facing cities in the South and to ensure more sustainable outcomes (Swilling, 2006).

One such way of revealing the dialectical relationships between society and space and society and the environment is through participatory planning and management. Participatory planning is a means of deliberating the future outcomes of the intersections or collisions of different knowledges, practices and experiences of the city (Cabannes, 2006; Whatmore, 2009). The concept of 'competency groups' is presented by Whatmore (2009) in her study on the relationship between science and democracy in mapping knowledge controversies. She outlines how 'competency' groups can be used to redistribute expertise. This could be used as a 'model' to allow for greater deliberation on spatial planning in cities.

Therefore, we focus on seven cities with contrasting economic and political conditions, with the scientific objective of developing a qualitative heuristic framework analyzing the ways in which participatory spatial knowledge management is linked to and can direct urban governance to sustainable development (SD). This framework will show 1) the influence of differing *political and economic conditions*, which can be either conducive or obstructive to more sustainable urban development patterns; 2) the ways in which different urban governance models address issues of economic growth, spatial and social inequality, and promote/degrade environmental sustainabilities, and 3) how utilizing participatory knowledge management and decentralized fiscal funding can support these initiatives.

The main question posed in this research report is how governments and citizens in cities with differing patterns of economic growth *make use of participatory spatialized knowledge* to direct urban governance to build adaptive capacity for sustainable urban development. Specifically, we have taken up the following issues.

1. Identifying the main actors involved in urban development and their relations (urban regimes and contesting groups); the actors involved in producing knowledge and the framings and discourses produced by each of the actors; the dominant planning and development discourses; and the conflicts between expert and local knowledges of other groups (lay knowledge).
2. Determining the extent of democratic urban governance, i.e. the degree of procedural justice necessary for sustainable decision-making, including the level of exchange and sharing of knowledge among stakeholders in processes and networks; the existence and democratic nature of participatory practices; and the way knowledge is used to exercise power in planning decision-making.
3. Analyzing spatial knowledges and their construction and utilisation; specifically, the institutionalisation of knowledge into policies, programmes and projects at the local, provincial and national level; the contestation around and resistance of dominant knowledge by civil society and the resistance of community knowledge by elites/experts; the extension of sustainability and democracy through the inclusion of alternative knowledges (methodological, participatory and policy making tools) in decision making.

1 (Bruckmeijer and Tovey call this the missing model, but in fact it has been experimented with widely outside the European context in which they are working)

4. Evaluating the implications of more participatory spatialied knowledge and utilization for outcomes in urban development.

Urban *spatialized knowledge management configuration (SKMC)* is the main concept we use to study the question of how urban development processes can be made more sustainable and inclusive, by looking at ways in which spatialized knowledge is drawn together (Latham and Sassen 2005). Spatial knowledges reflect a strategic set of resources, to which all stakeholders in urban governance processes can contribute. The question also concerns whether demands for, and contributions to, such spatial knowledge can become more inclusive, embedded and participatory in urban decision-making processes, and what the implications of this would be for more sustainable urban development outcomes.

This question fits into a broader debate on how urban policy-making processes are changing from processes in which government domains are the dominant locus of power to those in which networks of different actors participate in governance networks, i.e. the shift to a network society (Castells, 2000; Coaffee and Healey, 2003; Hajer and Wagenaar, 2003; Innes and Booher, 2003; Barnett and Scott, 2007; Baud and De Wit, 2008). This includes the discussion on how policy-making processes are being influenced by the rapid exchange of ideas, people, and technologies, linked through internet and other forms of exchange internationally and the fluidity of local combinations of such 'things' into urban assemblages (McCann and Ward, 2011; McFarlane, 2011a).

It also fits into the debate on how new forms of knowledge construction can provide strategic inputs into the socio-political processes embedded in urban governance networks. Looking at how interactive mapping processes are built on the expanding use of spatial, digitized information is at the heart of this discussion. Finally, this question fits into the discussion on building adaptive capacity in cities to deal with future challenges in the strategic domains encompassed in city development – economic growth strategies, dealing with social inequalities, and moving towards greater sustainability.

Therefore, we will deal with the issues posed in our main question against the background of these three broad debates, drawing on them to analyze the results from our city case studies, and answer our main WP5 research question.

This report first discusses the existing debates in the literature in more detail in chapter 2. These debates include the contemporary context of the network society, assemblages and the shift to interactive governance (IG), reviewing debates related to knowledge construction and recognition in urban development processes, spaces, and power relations in hybrid governance arrangements. The chapter then goes on to discuss how mapping processes, new data and digital technologies are becoming embedded in existing urban management processes and influence work processes, power relations between strategic actors and adaptive capacity for increasing sustainability in cities. In Chapter 3 the conceptual framework of (participatory) spatial knowledge management configurations is presented as the lens through which the comparative analysis of the city case studies is carried out, as well as the comparative interpretative methodology utilized. Chapter 4 presents the results of the case studies in the majority of the cities of the C2S research project, and chapter 5 discusses the linkages to and implications of SKM configurations in relation to the other domains in the research project. Chapter 6 provides conclusions.

2 Literature Review

In recent discussions on urban development, the role of knowledge construction, circulation and utilization are given increasing importance (e.g. McFarlane 2011b; McCann and Ward, 2011; Campbell 2012). This issue is raised in several debates, with varying emphases, usually not tied together into one discussion. These theoretical debates are dominated by discussions in the global North, which leaves wide gaps for understanding how cities in emerging economies deal with knowledge-related processes. As urbanization will be concentrated in the global South in the coming thirty years, it is essential to shift our attention to the transformative effects of changing knowledge management in cities in the South. In addition, expansion of digitization and communication technology

(ICT) and the spatialization of information worldwide are transforming knowledge management currently at a global level (e.g. Google Earth, Navigation systems, location-based services).

In this report, we discuss specifically how digitization and spatialization of knowledge production, and knowledge exchange and use is transforming urban governance in cities in the global South, setting the discussion within the wider debates on urban development and local governance processes. Although we draw on discussions around urban development from the North, we find that city governments in the South exhibit capacities, inequalities, different forms of embedding in international economic networks, as well as having very different historical contexts and political economies that require us to rethink some of the existing debates (Robinson 2006; Ward, 2006; Watson, 2009; Myers, 2011; Roy, 2011; Parnell and Robinson, 2013; Robinson, 2014). Therefore, this chapter discusses the major debates within which the questions in this report fit, specifically for cities in the global South.

2.1. Framing urban development discourses, knowledge construction and recognition in urban development

The first debate concerns the discourses on urban development, which have developed. Discourse, according to Hajer (2005, p. 447) is defined as " an ensemble of ideas, concepts and categorizations through which meaning is allocated to social and physical phenomena, and which is produced and reproduces in an identifiable set of practices". Each actor engaging in a decision-making process deliberatively, or standing outside the process as an activist, conceptualizes the planning or environmental issue in the form of a discourse that gives meaning to that issue. Laws and Rein (2003) use the concept of 'framing' to conceptualize how stakeholders create a framing discourse that gives meaning to their experience of policy issues[2].

Current urban development discourses run along three major lines; 1) the *changing mandates for urban local authorities*, particularly to stimulate local growth policies and to 'vision' city development entrepreneurially, in line with international expectations, 2) the promotion of cities as sites of consumption which provide attractive lifestyles and facilities, which raises the question of how to *deal with inequalities and differing levels of citizenship in cities*, and 3) the ways in which knowledge travels in *policy mobility* and the potential of the internet and other electronic means to stimulate such mobility across the world. In these debates, which are dominated by discussions in the USA and Europe on global city networks, the substantive focus is primarily on economic growth and development, and providing the facilities for a middle-class lifestyle (McCann and Ward, 2011; Kennedy et al. 2011). Although the necessity for governments to deal with inequalities is recognized, the discourses are usually couched in quite negative terms – with apocalyptic descriptions of inequalities (Davis, 2007) with a focus on policies of producing 'slum-free cities'. There is generally very little recognition of the contributions of non-standard settlement areas in building up cities economically or in terms of incremental building for habitat provision[3]. The alternative discussion on informality in cities focuses on lived experiences and arrangements which are not recognized by governments, and provides much-needed knowledge on emerging arrangements in practice (Roy, 2007, 2011; Rodgers et al. 2011; Jaffe 2013;).

International city networks are seen as an important means for knowledge construction and circulation, and recent discussions have suggested that hybrid arrangements are becoming more prevalent, in which a variety of knowledge sources are incorporated through networks of professionals across sectors, organizational levels and geographic locations (McCann and Ward, 2011). Several gaps remain in this debate. The emphasis of urban development discourses on growth ignores the necessity for including a discussion of discourses related to the provision of livable city habitats for urban residents; in the global South the extent of informality and non-standard settlements in cities make this a major requirement. In terms of knowledge networks and policy mobility, there is an implicit assumption of universal (individual) and easy access to digitized databases and Internet sources, as well as sharing and utilization of information and knowledge provided by these means. Given the prevalence of political policy-making and the power that access to information and knowledge provides, the openness and transparency of knowledge access needs to be thoroughly examined in the case of cities in the global South (Baud and de Wit, 2008; Kennedy. et al., 2011).

In network arrangements for governing urban development, the construction of information and

2 Discourse analysis places an emphasis on the importance of language in expressing interests, arguing a position and assuming a dominant position in decision-making processes.

3 Exception is the WB 2009 World Development Report on Economic Geography.

translating it into meaningful knowledge is an important but unruly process. There is a multi-vocality of views expressed by a range of stakeholders participating in decision-making, each 'voice' providing a different perspective and meaning attached to the issue (Hajer and Wagenaar, 2003). As common understandings and rules are forged, the 'institutional ambiguity' or lack of rules, inherent in network, decreases. This means that 'new spaces of politics' (Hajer and Wagenaar, 2003: 9) emerge with a new style of political involvement. With the wide range of stakeholders taking part in policy making, the myth of absolute knowledge is exploded and a need arises to take cognizance of the variety of discourses people adopt to make sense of their experiences and of the world.

How do processes of constructing and legitimating (spatialized) knowledge fit into this discussion? The first issue concerns the knowledge-building processes and types of information recognized by various actors, the second by what political processes information is turned into meaningful knowledge, and the third, the negotiations around whose 'knowledges' are prioritized to resolve the issues concerned (Cargo and Mercer, 2008, Schlossberg and Shuford, 2005, Whatmore, 2009).

It is recognised that dominant discourse emerge in specific contexts and when they 'travel' to new contexts, they become reproduced in a different context and recontextualised giving rise to what could be called a hybridization of the original framing discourses (Fairclough 2006).

Two basic analytical approaches are found on knowledge-building processes. The Mode I knowledge-building process, related to classic notions of knowledge as scientific-codified knowledge, is seen as being built up in linear processes of experimentation, verification and codification (Gibbons et al., 1994), or what Bruckmeijer and Tovey (2008) call the 'elitist model'. This knowledge-building process relies heavily on top-down expert and scientific knowledge systems, and framing discourses are heavily dominated by scientific and bureaucratic establishments.

The Mode II approach (Gibbons et al., 1994; Rip 2001), emerging since the 1990s, distinguishes different types of knowledge (embedded, practice-based, scientific) and recognizes knowledge-building as a social process, in which various framing discourses compete with each other through institutions and knowledge-building processes. Sources of knowledge can be from scientific research, working experience and the experiential, community-based knowledge of everyday life within various groups (Baud, 2002; van Ewijk and Baud, 2009). Bruckmeijer and Tovey also recognize the idea that knowledge processes are built up through social institutions, power struggles between groups for recognition of their definitions of problems and is a conflict-prone process, more in line with Hajer's (Hajer, 1995; Hajer, 2005) model of argumentative discourses. Bruckmeijer and Tovey have gone further than these two basic models, when they first elicited different discourses of SD (in the context of sustainable rural management or SRM in Europe), and then drew out from those paradigms the context in which they developed, i.e. where the knowledge for a particular view of SD was generated, codified, disseminated, applied and its level of success evaluated. This way of linking a combination of knowledge types (i.e. knowledge generation and recognition) to the main processes of knowledge management (linked to urban governance processes) is the essence of what we want to do in this research project. The other variants of knowledge dynamics that Bruckmeijer and Tovey distinguish include the 'political governance' model, in which the main assumption is that ideas for strategic changes for the future are basically 'political', and knowledge management is a derivative of the political discussions, which inform the ideas of social change needed.

Our starting point is also that various sources and types of knowledge can be recognized, and knowledge building is a result of the struggle over the social construction of knowledge. Different types of knowledge have been identified; ranging from tacit knowledge to contextual-embedded knowledge and codified knowledge (table 2.1.). The first is built up through individual practice and experience, which often remains non-codified in any way. It can only be taught from person to person. The next three types of knowledge are characterized by their contextual–embedded character, which can vary from more technical-economic sectoral embedding to embedding in social and political networks (Van Ewijk and Baud 2009; Patel et al., 2001). Finally, codified knowledge is that which is laid down in some form of documentation that can be accessed by others (not necessarily universally open), and learned through such documentation.

However, not all types of knowledge are given equal weight. In urban planning and management, formal technical knowledge is produced within various (local) government departments with their own sectoral perspectives (property, infrastructure, basic services, housing, water, energy, etc.), and increasingly also their own economic development policies, with provincial and national governments setting policies and standards for some areas. The main recognized actor networks in urban development consist of urban planners, architects, engineers and their research institutions and professional organisations. Conventionally, Development Plans provide the policy context, fixed standards are set for implementation

Table 2.1: Types of knowledge

	Tacit	Contextual-embedded knowledge; community-based, social	Contextual-embedded knowledge; technical, economic	Contextual – embedded knowledge: political and network levels	Codified knowledge (analytical, regulatory, standards, etc.)
Main actors	Individuals with experience	Community knowledge spread by social networks	Professional knowledge belonging to sector professionals	Political knowledge within political and social networks	Academically and professionally taught and diffused

Source: Adapted from van Ewijk and Baud, 2009

and expert knowledge provided by planner and other experts are the dominant paradigm within which actors work. The type of knowledge constructed and produced is therefore embedded and is largely technical, regulatory and codified.

This dominant paradigm of urban modernization framing economic, social and environmental management and planning processes adopts an "expert-led, science based policy framework" (Oelofse et al., 2009; Scott and Barnett, 2009). Scientific experts argue that such processes are highly complex and only science can provide an authoritative base for policy-making. They therefore define problems and their solutions and this provides a powerful claim that policy-making should be based on scientific knowledge only (Fischer, 2003). Power is ''inherent in the knowledge claims and various practices through which specific scientific claims gain authority" (Hajer 1995). This 'science-based policy-making' model has been extensively criticized in terms of the ways in which a range of actors, including state and business interests, strategically use science to frame their views on developmental issues, claim authority and exert power in decision-making processes. However, in contemporary society, where 'hard decisions' have to be made hurriedly with only 'soft' evidence, the role of expert knowledge in decision-making has been challenged, with increasing mistrust of science and a call for local, embedded knowledge in policy-making (Fischer, 2003; Yanow, 2003; Ravetz, 2004; Hajer, 2009, Scott and Barnett, 2009, Whatmore, 2009)[4]. Citizens are increasingly aware of the failure of science and expert knowledge applied by the state to address contemporary environmental and social problems. There is increasing unease and anxiety in society which has been brought about by the 'democratisation of knowledge' (Hajer and Wagenaar, 2003). There is currently a discussion on whether there is an emerging mode III, where expert SKM is bypassed and contested, or embedded in a citizen and media counter-mapping movement rendered possible by the democratization of mapping tools (Web 2.0, Geoweb, Google Earth, GPS and mobile GIS), access to geo-databases and collaborative construction of information (more and more in real time). It's more than participation, and less than processes channeled by official institutions (Poorthuis pc; Leszczynski and Wilson 2013).

2.2. Urban Governance: arrangements, spaces, and interactions

We now turn to the debate concerning actor networks involved in managing and planning cities, and the spaces within which information and knowledge is circulated to improve transparency and accountability. A major concern is about which actors are involved in the discussions of city policymaking, and the degrees of power they have to express their priorities. On the one hand, the discussion focuses on the power of the coalitions between local authorities and the private sector (regime theory), on the other hand, the discussion focuses on the relation between local state and civil society (participation and 'spaces' approaches, citizenship discussions) (e.g. Cornwall and Gaventa, 2001; Gaventa 2006). Both come under the heading of governance arrangements.

Governance arrangements

Today it is a truism to state that the state no longer represents the sole 'locus of power and authority' in

4 Wynne defines lay knowledge as falling within ''an adaptive, informal cultural idiom" pointing to the experiential and cultural base of local knowledge (Wynne, 1992, p. 287, cited in Scott and Barnett, 2009).

contemporary global neoliberal society and power is shared more widely with a range of civil society actors (Hajer, 2003; Parnell et al., 2002; Hajer, 2005). Policy making increasingly is seen to be taking place through networks of actors who are "relatively stable sets of independent, but operationally autonomous and negotiating actors, focused on joint problem solving" (Hajer, 2005: 241). These actors include the state, NGOs, business, consultants, scientists and civil society. Such organizational interaction is particularly necessary to solve 'wicked problems' (van Buuren, 2009; Giezen 2012). Authors differ in their interpretations on the extent to which increased participation (inclusion of more actors) or more deliberative processes (direct engagement with citizens rather than their representatives) are taking place in policy decision-making (Young, 2001; Innes and Booher, 2004; Barnett and Scott, 2007a; Janicke 2009). There is also debate around which types of decision-making spaces are being created (invited, claimed or negotiated), and what knowledge and information is constructed to inform decision-making processes (from expert to community-based) (Miftirab, 2004; Bruckmeijer and Tovey, 2008; van Buuren, 2009; Whatmore, 2009; Giezen, 2012).

The main characteristics of 'governance' models are that they:

a. provide for a changing role for government itself;
b. recognize other actors beside government (private sector and civil society organizations);
c. include more space for ideas and participation from other actors (to a variable degree, not necessarily equally for all participants);
d. have more strategic and flexible processes of planning and management, which can take changes into account;
e. can lead to more synergy in developing new approaches (Baud and Dhanalakshmi 2007);

The role of government has changed in that a 'political reorientation' is taking place from:

a. "bureaucratic detailed rule-making to an emphasis on steering the framework conditions and action context;
b. a state mode of dealing with problems to a societal mode of handling them, with the inclusion of the state;
c. a centralist to decentralized problem-solving;
d. exclusive to ever more inclusive and participatory decision-making structures;
e. an imperative policy style to negotiated solutions;
f. a reactive to a more strongly anticipative policy pattern; and
g. steering based on public expenses to strengthened steering based on public revenues (taxes, levies, tariffs, fees)" (Jänicke, 2009: 35).

These changes imply that governments are moving from bureaucratic, administrative decision-making to more knowledge-based, strategic decision-making processes. Although this change may be occurring in high-income countries, the extent to which it is taking place in emerging economies is an important question (see Kennedy et al., 2011).

A first question is the extent to which governments recognize and work with other actors. One strand of thinking has examined the extent to which civil society is 'included' or 'excluded' from the state-led processes of policy-making (Dryzek, 1996; Bulkeley, 2000; Hordijk, 2000; Young, 2001; Yanow, 2003; Gurza-Lavalle and Isunza-Vera, 2010). This literature brings out the unevenness of representation of social groups in networked processes of policy-making and implementation, in which middle class groups can utilize the new networks to a larger extent than more marginalized or vulnerable social groups, unless great care is taken to include them explicitly (Gurza-Lavalle et al., 2005; Baud and Nainan, 2008). This has stimulated debate around concepts of democracy and citizenship, as the contemporary policy making arenas and public participation approaches are critiqued for a lack of representation in decision-making (Innes and Booher, 2004; McEwan, 2005). This literature has also stimulated discussion on the strength of emerging forms of citizenship built up within social movements and civil society organizations to empower their members and engage with state institutions (e.g. Barnett and Scott, 2007b; Holston, 2008; Scott and Barnett, 2009).

A second question pertains to the extent to which governments have preferred to engage with 'networks' of economic actors in policy-making in the current neo-liberal context. This strand of research focuses on the relations between government and the private sector under the framework of 'urban regime' theory. In the North American context, there has been much critical analysis of the implications of such public-private coalitions, which are seen to prioritize agendas of economic growth over those relating to quality of life issues and promoting equality among citizens in urban areas (e.g. Lauria, 1997; Brenner, 2004; Robinson, 2008). Research on such coalitions in the global South is scattered. Studies in India have tended to focus exclusively on the mega-cities of Delhi and Mumbai (Anjaria and McFarlane 2013), investigating the regime

shift to growth coalitions (e.g. Banerjee-Guha, 2002; Nainan, 2011; Dupont, 2011). Robinson (2008) has commented on this prioritisation of economic goals in the South African context.

Such studies suggest strongly that the concept of 'inclusion' in deliberative forums and governance structures needs to be considered very critically. It is not enough to be 'included' in processes of policy-making and deliberation; the extent of inequality on which such inclusion is based, and how the concomitant power relations shape the extent of inclusion and ability to interact need to form part of such an analysis to assess its potential for deepening democratization (Swyngedouw 2005; Torfing et al. 2012). It also requires an analysis of the extent of non-state knowledge brought in by 'included actors' is recognized and given equal status with the expert-scientific knowledge utilized – in other words, **interaction** rather than inclusion should be the focus. This also implies more attention for how 'spaces' of interaction between state and non-state actors are structured and provide opportunities for interaction; the rules of engagement within and around such spaces structuring power relations governing how actors engage with each other, and the sets of knowledge recognized as legitimate framing discourses within them (Torfing et al. 2012).

The discussion in the literature has moved from that around partnerships and network arrangements, to recent ideas of hybrid arrangements. Both *multi-actor and multi-scalar networks* come under this heading (including e.g. networks between different scale levels within government, or social networks working at local, national and international levels) (Barnett and Scott, 2007a) or cross-boundary networks (city-to-city cooperation by local governments, slum dweller networks, regional cooperation in economic development) (van Ewijk et al 2014; Bontebal 2008; Sassen 2005). The main question is what power CSOs representing various social groups have developed to put forward their visions of urban development and how the lived experiences of marginalized social groups is incorporated in decision-making. The deliberative processes by which such power is built have been widely discussed, particularly for South America where they developed originally, but also across the rest of the world (Fung and Wright 2003; Gurza Lavalle et al., 2005; E&U, 2012: special issue[5]). We draw out a few relevant issues from this very large debate here.

Deliberative processes and the political contexts in which they take place have provided platforms for developing stronger forms of citizenship among marginalized groups (Heller 2009; Heller and Evans 2010). 'Negotiated spaces' provide possibilities for ongoing discussions between urban residents and government, although the channels and degrees of power remain quite variable for the middle class and those less recognized as urban citizens (cf. Chatterjee 2004; Baud and Nainan 2008; van Dijk 2014). Also the extent to which legal frameworks mandate and protect such processes makes an essential difference to the power which marginalized social groups can develop through deliberative processes (Ackermann 2004; Shatkin 2007). Such spaces provide platforms for producing citizen-based contextual-embedded knowledge (civic science) and bringing such knowledge into the political discussions within networks, as part of counter-mapping processes (Castells 2001; Healey 2007; Scott and Barnett 2007; van Ewijk and Baud 2008). This is proffered as a major advantage of such deliberative processes (cf. E&U 2012 special issue).

In several countries, with Brazil as a prima example, deliberative processes have been institutionalized at neighborhood levels, and more recently at provincial and national levels (Appadurai 2001; Cabannes, 2004; Gurza Lavalle et al., 2005;). These processes have included lay knowledge and citizens' preferences for public interventions, and have increased the sourcing of the knowledge used in determining priorities. In India, projects for improving large-scale city infrastructure have incorporated forms of deliberative processes in which community mapping has provided knowledge on numbers of households involved, and their priorities (Patel et al., 2012; Hoyt et al 2005; see E&U special issue 2012). However, the incorporation of such knowledge had to be protected by the context of international donor agencies mandating deliberative processes, and remains more fragile in contexts where such legal mandates are not in place.

Even more fluid combinations of people, ideas, things, etc. are the basis of recent conceptualizations of how cities work, through assemblages (e.g. McFarlane 2011a). In this conceptualisation, knowledge travels easily across national boundaries, between institutions and is combined from various sources, making urbanism and its policies mobile (McCann and Ward 2012; Ward 2006). The implications of this approach are very relevant in relation to the social media and other ways of digitising spatial knowledge. However, the major part of research on policy mobility is based in high-income countries, and the question remains to what extent such assumed conditions hold true in the rest of the world. In particular, the ways in which policies are imported, transformed and translated through local socio-political contexts means knowledges sourced internationally can become locally-negotiated

5 Special issue in Environment & Urbanization 2012, 24(1), p. 3-390

(Fairclough 2006). Tracing the fluid process of assembling knowledges across different types of boundaries can reveal more holistic understandings of the different scales of interactive governance.

In the assemblages approach, the construction and production of knowledge includes the analysis of city life and the knowledge of 'lifestyles' of particular groups of residents (households and social networks) in building city 'spaces' (Lefebvre 1971). This approach recognizes the 'narratives' produced by residents from all walks of life, and the extent to which social codes become mandatory in particular areas of the city. It relates also to livelihood strategies and well-being priorities residents in each area set and their need to know the social codes to operate safely and maintain their own habitat and livelihoods in the areas where they live. An important issue in this respect is the ways in which such narratives can be exchanged across social classes, areas of the city and between different actors in order to build trust in alternative 'narratives' and lifestyles (Jaffe, 2013). It includes the ways in which collective action, social organisations and movements can contribute to increasing community-based knowledge across social and political boundaries, especially of less powerful groups (Hordijk, 2000; Miranda and Hordijk, 2001; Patel et al., 2009; Scott and Barnett, 2009). It relates to what Massey (2005) calls the knowledge of everyday space. Such spaces and the knowledge of them are 'constituted through interactions, from the immensity of the global to the intimately tiny' (Massey, 2005, p. 9). Because urban space is the 'sphere of coexisting heterogeneity' there are a multiplicity of knowledges of this space' (Massey, 2005, p. 9). Spaces and the knowledge of spaces are therefore always under construction, 'never finished; never closed' (Massey, 2005, p. 9). It is a necessary complement to produce more inclusive and interactive approaches to urban development.

Spaces

Governance arrangements and the processes by which urban spaces are constructed, require a further reflection on what is meant by space and spaces. Space is a complex concept that includes ideas about physical (absolute) space and socially constructed space, and the powers and politics that help shape spaces (Jessop et al., 2008; Sutherland, 2010). It is therefore useful to apply theories of relational space to understand urban spatialities, or urban geographies, being produced in fast growing cities through planning interventions, private sector initiatives, collective and strategic civic organization and social network activities, and household urban survival strategies. The main theoretical ideas on space that are applied here are drawn from Lefebvre's (1974) work on the production of space and Massey's (2005) ideas on the construction of space. Lefebvre's (1974) triad of space contains three concepts of space: material space (spatial practices), representative space (conceived space) and representational space (the space of the everyday lived world). Material space or spatial practice is reflected in the patterns of daily life and it provides a structure for everyday life. Spatial practices include networks and routes, institutions and patterns of interaction that link the places that embrace working life, home life and the life of leisure (Lefebvre, 1974). These practices hold "production and reproduction, conception and execution, the conceived and the lived, and somehow ensure societal cohesion, continuity and what Lefebvre (1974 p. 33) calls a 'spatial competence' Spatial practices are revealed by deciphering space and have a close relationship with representative (perceived) space. They include the tools used to order and construct space, to keep people in or out, such as property ownership, routes and networks.

Representative space is the space of planners, engineers and cartographers. It is a constructed, abstract and often presents a space that represents and produces a conceived reality, e.g. a town planning scheme or a spatial development framework. Private sector actors have a strong say in constructing these spaces. These spaces have great power in structuring and producing urban geographies. The everyday lived spaces of ordinary citizens intersect and collide with these representative spaces. As a result, both both abstract and everyday spaces shift and change, with the dominant form of space in each particular context being asserted, thereby remaking or reconstructing space.

Representational spaces are the material spaces of everyday life infused with particular spatial imaginations. They resist the dominant ordering of space and society by creating 'spatial alterity', which allows for alternatives that challenge economic and bureaucratic abstraction, enabling symbolic spaces to emerge (Dierwechter, 2001). Soja (1996) refers to representational space as 'third space', as it contains alternative possibilities to those presented by the dominant spatial system of spatial practice and abstract spaces.

Massey (2005) reflects on the concept of space through three main propositions. She states that space is a product of interrelations, as constituted by interactions at all scales; that space is about multiplicity and the interaction of multiple trajectories; and that space is always under construction. It is always "in the process of being made. It is never finished, it is never closed" (Massey, 2005, p. 9). She too acknowledges physical, conceived and lived space and explores these concepts through her ideas of the 'stories-so-far of space' that are made up of multiple

interactions and relations of the material, abstract and imagined world.

The concept of space has also been used from a more political perspective (although it can pertain to particular geographic locations). Cornwall and Gaventa (2001) distinguish 'invited' and 'claimed' spaces; the former being those arenas in which the state invites citizens to present their ideas on decision-making concerning the issue at hand, in order that they be taken into account. Claimed spaces are those areas in which groups of citizens themselves construct ideas about particular areas of concern, and put these forward to authorities outside the consent of the government. A third type of space has been put forward by Nainan and Baud (2008) – 'negotiated space', which suggests that (re)negotiation of construction of spaces takes place regularly between government and certain groups of citizens.

In such spaces, the extent of stakeholder participation in decision-making is the crucial issue. A great deal of research has been done describing and critiquing public participation, with the general conclusion that public participation generally fails to democratically include all stakeholders equitably in decision-making processes (Arnstein, 1969, Innes and Booher, 2004, Scott and Oelofse, 2005). Equally large is the body of normative literature proposing tools and techniques to increase the democratic quality of participation (see Mitlin and Thompson, 1995, Innes and Booher, 2004, Oelofse et al., 2009, Whatmore, 2009). An example is the need to explicitly include 'invisible stakeholders' into decision-making processes (Oelofse et al., 2009, Scott and Oelofse, 2005, van Teffelen, 2010).

From participation to interactive governance processes

This brings us to the issue of how power is exercised within various types of governance processes, and what the implications are for knowledge generation, exchange or contestation, and how these processes shape the outcomes for urban development (strategies). This section recognizes that participation in governance concerns the inclusion of a variety of stakeholders, whereas interactive governance assumes implicitly that discussions and negotiations are two-way processes, albeit not necessarily with similar resources to bring to the table. Torfing et al. (2102) indicate that the interactive governance literature contains specific assumptions about how power is exercised, which are not borne out in practice. Participatory and interactive governance is considered to consist of pragmatic problem-solving processes where all involved actors have a common stake in depoliticized non-conflictual ways of solving issues. This is part of a broader 'post-political' vision on contemporary society, in which issues are addressed by managerial patterns of resolution (Mouffe 2005, quoted in Torfing et al. 2012). The celebration of interactive governance rests on its 'third' way of solving issues between market and hierarchy (Healey 2007), with flexibility, innovation, mobilization and empowerment as important dimensions, but neglecting the actual conflicts, power struggles, and disruption in practice (e.g. Nainan 2012)[6]. It also rests on the assumed sense of underlying harmony within such networks, with "persistent emphasis on shared meanings, solidarity, and the civilization of conflicts" (Torfing et al. 2012: 54). In analyzing interactive governance processes, we cannot start from such assumptions. Rather, the focus should be on the *ways and strategies* by which such shared meaning, solidarity and cooperation are built up, i.e. the ways in which power relations are incorporated in participation and interactive governance processes and how they can be undermined by power inequalities and divisive conflicts.

Power in interactive governance can be defined in four ways; direct and indirect power, ideological, and discursive power (Torfing et al. 2012, adapting from Lukes, 1974). The first three definitons of power are actor-based, whereas the final set refers to the ways that institutionalized systems of meaning structure actors' ideas (Ibid. p. 56). In participatory processes, power is often exercised in more indirect ways, in which knowledge sourcing and its validation are important means of influencing other actors. Particular hegemonic discourses (such as scientific-technical framing) and their suggested solutions receive preference over alternative explanations (Hajer, 1995; Hajer and Wagenaar 2003). Codifying and naturalizing ideas are processes by which a dominant discourse is built up.

It is relevant to distinguish actors' attributional and relational power in networks; attributional when it concerns their capacities and resources and relational when it concerns their social and bargaining power (Kahler 2009). This helps us assess existing inequalities and starting positions when analyzing participatory processes. We also need to recognize their cyclical nature; in a build-up phase, such networks may be very fragile, with little trust, limited support, unclear rules and conflict around policy definitions and negotiations, whereas in a more consolidated phase, the legitimacy of a network may have been well established, reducing conflict and increasing the power of its actors to influence policy-making (cf. Torfing et al. 2012: 59). The

6 See Torfing et al. 2012 for a systematic discussion of various reasons why power conflicts are not recognized within the new network and participatory approaches to governance (p. 49-54).

literature suggests that issue networks are less stable over time than policy communities (ibid. p. 60).

The legitimacy of a governance network strongly influences the uptake of its knowledge and policy recommendations. Such legitimacy can be gained from the quality of inputs (who is participating), the throughput (processes according to notions of fairness, responsiveness and transparency), and outputs (in terms of promising solutions or trouble-shooting (ibid. p. 61)). The acceptance of particular knowledge framings should also be a factor included in the discussion on legitimacy, as alternative framings often have to fight for acceptance before the substance of their arguments is even considered.

Finally, we need to consider why governments utilize participatory and interactive governance processes and how this structures the influence networks can bring to bear on policy and strategies. Expediency (to solve a wicked policy problem) and a multiplier effect in mobilizing actors around preferred solutions are two reasons for more inclusive processes (Torfing et al 2012). More ownership, political legitimacy, and the need to contain social conflict, may be others reasons that lead governments to adopt a networked approach (van Buuren 2009).

The extent to which governments provide power to interactive networks sets strong external limits to what such networks can achieve. For instance, in the participatory budgeting processes the size of the budgets dedicated to participatory processes, the extent of decision-making powers, the actors included, and the scale levels and domains concerned differed widely, reducing or expanding the power of these processes to change urban outcomes (cf. Fung and Wright 2003; Cabannes, 2004; Hordijk, 2005). The following table indicates the ways governments can exercise power over interactive governance domains and processes.

Regime, assemblage and urban configurations

Conceptualising how power is dispersed throughout multi-scalar governance arrangements requires moving beyond the idea of a network. It is not that all 'included' actors are on an equal footing in the horizontal planes of traditional urban regime theories; rather, the complex ensemble of relationships and power relations create hybrid arrangements which do not fit a predefined formation. Assemblage is a concept that helps to grasp non-linearity without reducing the grouping to its component parts. Neither dispersed nor standardized, an assemblage is a fluid arrangement of different clusters of ideas, actor coalitions, spaces, materials and their relationships. It is the very processual relationships between these that define

Table 2.2: Maintaining power over interactive governance (IG) networks and processes; links to knowledge generation (G), exchange (E) and utilisation (U).

Power Maintenance over IG	Explanation	Knowledge G, E, U
Power to open up and close down IG arenas[7]	In and exclusion processes of actors and domains	Hegemony of expert of knowledge; exclusion of contextual-embedded knowledge; knowledge silos – little exchange; no U of outside knowledge
Regulating access to IG arenas	Strengthening or weakening particular actors	Recognition of particular types of knowledge, and non-recognition of others
Constructing the agency of those participating in IG arrangements	Citizens as subjects, clients or voters, private organizations	Establishing mandates for knowledge of particular agents/organisations
Framing negotiating interaction in arenas	Legal and normative frameworks; framing discourses	Establishing cross-organisational mandates
Assessing performance of IG arenas	Monitoring, evaluation,	Systemizing and institutionalizing new criteria for knowledge-based assessment

7 Torfing et al (2012) also distinguish changing the overall architecture of IG policy arenas, which seems to overlap with the 'power to open up and close down IG arenas' to a large extent.

the assemblage, bringing elements together without losing their heterogeneity and changeability, but neutralizing conflicts and dominance (Deleuze and Guattari 1987, Delanda 2006). Assemblages are porous, and a particular element can be part of several at the same time. It is a radical perspective that precisely highlights "the heterogeneity of such arrangements, throw[ing] into question the very idea that there is such a coherent and consistent formation" (Allen, 2011: 154).

Rather than simply thick description, the assemblage perspective requires an analysis of the production of power relations (Brenner 2011). In doing so, it opens up new avenues for sociospatial inquiry, particularly around the strength of emerging forms and the continual shifting of relations across space, time, scale and boundaries (McFarlane 2011) whilst remaining firmly anchored in locally negotiated arrangements.

In the context of urban governance, assemblage is particularly relevant because it allows a deeper understanding of how power packages are put together through interaction. With the rise of the Internet and global communications, ideas, knowledges and policies are mobile and can be drawn into assemblages across boundaries, changing the dynamics of local governance (McCann and Ward 2011). However, thus far, research perspectives are dominated by experiences of cities in the global North, with both experiences and perspectives from the Global South just starting to emerge (see Dovey 2012). Knowledge creation, sourcing, and transformation are multi-scalar and multi-spatial issues that can uncover different nuances of inclusion or exclusion and the implications this has for seeking new sustainabilities. The question is then how these configurations are put together from local and global sources and the implications of such processes.

However, the assemblage perspective is almost too fluid for practical applications, assuming that everything is constantly in flux. Particularly in the context of the global South, there are enduring sociopolitical and economic features which bring some stability to multi-scalar governance arrangements. In this sense, the notion of configurations of governance lie at a midway point between the stability of regime and the fluidity of assemblage theory (Baud et al. 2013). Configuration as a concept allows an analytical openness to the emergence of power relations from complex interactions with uncertain directions, particularly with new issues changing all the time, but also indicates that such assemblages have a staying power over time (path dependency).

In this section we have discussed the ways that knowledge is embedded in epistemic communities and in urban management and development processes. In the next section we turn to two recent transformations in constructing knowledge; namely, the explosion of digitization of data, information and subsequent knowledge, and the 'spatialization' of knowledge construction. The latter is linked to the massive increase in the use of mapping tools and geographic information systems with user-friendly platforms and programmes (Google Earth, navigation tools, etc.) which are likely to affect the sourcing, construction and use of information and knowledge.

2.3. Knowing and governing urban development through ICT-GIS based knowledge

Digitizing and spatializing knowledge

The third debate concerns the ways that knowledge is built and contested in urban knowledge management systems (cf. van Buuren 2009; Baud et al 2011). There are two major strands to this discussion currently; one is on the issue of producing spatialized knowledge ('mapping') and associated technologies, and the other is about the opportunities provided by digitization and digital databases, mobile phone networks and the Internet ('ICT-based' knowledge construction and exchange). The former is interesting for our discussion because it discusses how the construction of maps incorporates specific views of the issues shown (Wood, 2010; Monmonnier 1991) and how constructing maps is an iterative process reflecting ongoing thinking (Pickles, 2004; Kitchin and Dodge, 2007; Kitchin, et al 2013).

The discussion on what spatialization of information and knowledge contributes to knowledge-building concerns three levels; the first concerns the added value of visualizing the geographic distribution of phenomena, showing the concentrations of events or trends, also referred to as geographic governance. This is particularly strategic, given our interest in urban inequalities and urban 'geographies of injustice' and what spatializing information can contribute to a more targeted urban planning and management, or exacerbate existing inequalities (Baud et al 2011; Martinez 2009). The second level of discussion on the spatialization discussion concerns more specifically the methodologies of producing spatial information and knowledge, which can both make visible or hide information according choices made in terms of framing the issue, knowledge sources and classifications used. The third level is the actual collection, creation and structuring of spatial databases, providing the

basis for mapping (level 1) and more advanced analysis (level 2). We will discuss these levels here, as related to our subject (section 2.3.2 and 2.3.3).

ICT-based processes and systems are interesting because they potentially enable and facilitate communication and sharing of information and knowledge within government and across its line departments (G2G), from government to citizens (G2C) as well as from citizens to government (C2G), but also among citizens and citizen groups (C2C)[8] (e.g. van Teeffelen and Baud 2011; Martinez, Pfeffer and van Dijk 2011; Prins et al. 2012). Examples for each process are streamlining work processes within government, providing administrative information and online-forms to citizens, receiving citizen feed-back on service provision, and finally, initiating political discussions in cities by means of the internet (e.g. Google Earth; Wikipedia; http://www.chequeado.com in Argentina) or constructing social knowledge in civil society organisations. Digitization potentially enables governments to be more effective in its work and less corrupt (Ministry of Urban Development, 2010), but also more transparent and accountable towards citizens, as well as providing means for integrating citizens' perspectives (Martinez et al, 2011). Paradoxically, the privatisation of government services undermines this potential.

Geographic governance through spatial knowledge construction and use / mapping

"*Maps need to be related to what happens in the background*" (AAG conference participant 2014).

Geographic governance concerns political decision making, policy-formulation and management of people, assets and resources in geographic subdivisions for which geographic information technologies, and maps in particular, are considered to be a vital source of geographic knowledge (Crampton, 2004). For a long time, maps were considered as objective, neutral representations of reality (some kind of 'mirrors of nature') by means of scientific techniques that capture and visualize spatial information (Kitchin and Dodge, 2007). The high-resolution poverty map produced by Charles Booth in the late 19th century in which he only included data which, according to him, were highly accurate and therefore scientific (Söderström, 1996), provides early evidence of this kind of thinking. However, maps are not value-free; they are laden with power and are socially constructed (Harley, 1989). Different actors in different context; social, political, cultural and economic, will produce, represent and use information in different ways (Crampton, 2004). The choice for thematic conceptualisations, knowledge sources and geographic scales "reflect and constitute specific ways of framing and solving problems of governance", the prevailing political thinking and its transformative potential (Crampton, 2004: 41). Accordingly, maps as products cannot be understood without relating them to the context in which they were produced and unravelling the implicit assumptions and choices made in the mapping process. Moreover, maps are ontogenetic in nature; "…of the moment, brought into being through practices (embodied, social, technical), *always* remade every time they are engaged with; mapping is a process of constant reterritorialization" (Kitchin and Dodge, 2007: 335). Maps are thus viewed as beings, rather than as objects at a distance (Crampton, 2004). There is an evident move towards a more comprehensive study of mapping as practice (Kitchin and Dodge, 2005), the types of knowledge employed (e.g. Brown and Laurier, 2005), as well as the context in which maps are produced, used and exchanged (Crampton, 2009).

Accordingly, maps as products of mapping processes and multiple codifications not only represent place in its space and provide knowledge on particular social and spatial stratifications, but also produce and utilize knowledge in an iterative way, thereby shaping spatial, social and professional practices and our understanding of space. Maps have the transformative potential of producing and shaping space by influencing the way urban space develops and is produced, both in terms of its geography and social and economic fabric (Söderstrom, 1996; Pickles, 2004; Perkins and Dodge, 2012; Gabriel, 2013) as well as how it is governed (e.g. redlining in Aalbers, 2005). A set of points, lines, and colours that takes form as, or is understood as, a map through spatial practices (Alberts, 2014) and mapping processes is enacted to solve relational problems (Kitchin and Dodge, 2007). Mappings 'rework' spatial knowledge, and in so doing, undertake some kind of work (e.g. inscribing territory, shaping and framing a discourse, informing policy-formulation and providing evidence for decision-making processes, pronouncing differentiation) through practices like drawing, recognizing, interpreting, translating, communicating, determining, denying (Pickles, 2004; Kitchin, 2013). Maps also author and read at the same time (Del Casino and Hanna, 2006). They unfold through "a mix of creative, reflexive, playful affective and habitual practices" combining the skills, knowledge and experience of the actors involved in the mapping (Kitchin, 2013: 481).

8 A number of abbreviations are used in this paper; MIS = management information system, G2C = government to citizen, C2G= citizen to government, G2G = government to government (departments or scale levels), C2C = citizen to citizen (also including social media, volunteer geographic information), LG=local government, and PPP=public private partnership.

With the emergence of GIS in the social sciences in the mid 1990s and later on (see e.g. Pickles, 1995; Sheppard, 2005), GIS products were critiqued as not being objective and neutral, but determined and shaped by their context in which they have been developed. The increasing implementation of geoICT in public bodies (see e.g. Richter, 2014) and elsewhere and the geocoding of lived realities, both providing the ingredients for combing information sources based on their geolocation, diverges into two strands: the 'objective truth' providing the solution to a problem versus a critical debate centred around democratisation, inclusion and inequality, data reliability and accuracy, usability as well as transparency (e.g. Haklay, 2013; Leszczynsku and Wilson, 2013).

Methodologies of spatial knowledge production, use and exchange

This section deals with various *methodologies* of spatial knowledge production, use and exchange, and in particular the recent striking changes in the technologies and the ways of how knowledge is constructed, utilized and shared, for which purposes and in what context (Pfeffer et al, 2013). The changes concern the digitisation and spatialization of information and knowledge in most domains, supported by (spatial) technologies like geographic information systems, remote sensing tools, GPS-enabled mobile devices, web-mapping services and the GeoWeb (=collaborative GIS-based platforms), but also the global spread of the internet and its uses, such as social media and other web 2.0 applications. These changes have been accompanied by changes in scientific methodologies, such as the construction of poverty maps or the application of scenario building methods.

The *processes* through which knowledge is generated, used and exchanged including the actors involved are characterised by varying degrees of interactions (no participation, cooperative interaction or contestation), which take place at different scale levels and may range from being a linear process to a more socially constructed process. This also includes wide-ranging implications for the ways in which different types of knowledge can be included to reflect on the priorities of various urban communities, the spread of technologies and the access that various groups have to such technologies, their familiarity with technologies and methodologies, and the extent to which such forms of knowledge empower marginalized groups or increase surveillance across society.

In the following sections, the purposes, processes and methodologies of spatial knowledge construction, use and exchange will be elaborated in more detail and with an urban focus.

Purposes

The main purpose of spatial knowledge construction, use and exchange is for knowing ('mapping') and governing urban resources; specifically to inform political decision-making and policy formulation and their management. In the urban context, resources refer to people in place, available land and its value, environmental resources like water quantity, quality and risks, economic and financial resources as well as infrastructure and urban amenities. Examples are producing population distributions for designing effective interventions, collecting and monitoring property tax for administrative purposes, creating spatial imageries of future city visions or developing alternative knowledge to challenge official knowledge.

Geographic mapping, spatial imageries and tables and lists (with or without technology) are frequently used to classify people and space into manageable and governable entities (Crampton, 2004). They are also used to administrate and monitor urban resources (facility maps, cadastre maps, delineation and classification of the urban area, monitoring urban space such as the emergence and growth of informal settlements), or determine and classify current and future land uses (e.g. in the form of land-use and zoning maps or spatial development frameworks). The latter calls the future into being and gives power to the professional land use planner (Söderström, 1996).

In addition, cities need to be prepared for risks and hazards that affect the city like natural disasters, disease diffusion, food security, water scarcity or waste management. Spatial knowledge management may help developing ways of dealing with these risks in an effective and sustainable manner.

Table 2.3 provides an overview of the knowledge demands of cities, both related to their mandates as well as the influences from outside that affect cities like natural disasters, in relation to potential knowledge sources and technologies and methodologies for processing and further utilizing these.

Spatial technologies and scientific methodologies

Geographic information systems (GIS), having become mainstream in organisations dealing with spatial problems for managing all kinds of resources, assets and services– people, land, environmental resources, infrastructure and facilities in particular – are, from the technocratic point of view (GIS believers), considered powerful tools for producing

9 Pfeffer developed this tale, inspired by Rakodi 2003.

Table 2.3: Elaboration of knowledge demand of local government mandates and external influences affecting urban areas[9]

Mandates of LG	Knowledge demand	Potential knowledge sources	Potential knowledge instruments/GIS applications
Generating revenues, e.g. property tax collection or water billing	Size, age and location and ownership (or change in) of property; calculation of real estate value	Georeferenced cadastre map of footprint of property Attribute data (size, owner, history)	ICT/GIS-based property tax information system
Urban amenities/ facilities	Location, type and capacity of facility	Geographical coordinates of facilities	Location-allocation models; service areas
Land use planning	Suitability of land for differentiated	Map of current land use/ planned land use	Master plans Decision/planning support systems
Basic service infrastructure provision and maintenance	Infrastructure nodes and network, attributes	Schematic / GIS map of infrastructure	
Public administration	Birth, Death, Migration, housing	Census, municipal registrations, surveys	Statistical tables and analysis; maps e-governance tools
Quality of life / needs assessment	Income, employment, health status, housing stock, resources	Census, municipal registrations, employment databases	Indicators; (GIS-based) Monitoring systems
Disaster management	Location and extent of hazards Vulnerable areas	Hazard maps, zoning maps of vulnerable areas, disaster event databases	Vulnerability mapping, prediction models

and communicating objective, scientific knowledge about the urban environment (this thinking has emerged more strongly in the smart city discourse, which suggests that real time spatial data can be generated and used to make cities ore sustainable, such as Kitchin 2014). Given the availability of and access to accurate spatially referenced digital databases on land use, resources, linear infrastructures and facilities, housing types or population, sector-based spatial knowledge of the urban environment can be constructed and visualized in a linear fashion to inform urban planning and management, policy formulation and decision-making processes. Potential roles for GIS applications in cities, to some extent also covered by Rakodi (2003):

1. Strategic planning (creation of land use plans; land suitability analysis for identifying urban areas suitable for certain types of developments; designing boundaries, borders and contours),
2. Disaster management (hazard and risk mapping to identify vulnerable areas exposed to environmental hazards and risks),
3. Monitoring environmental variables and threats (air pollution monitoring, crime statistics),
4. Needs assessment (generating policy-information on people in place highlighting areas which lack financial resources or inadequate access to housing or basic infrastructure, often based on census data, population registrations or surveys; identifying areas in need of infrastructure improvements with respect to transportation, utility infrastructure or urban amenities),
5. Transportation planning, and
6. e-Governance, both as internal management information systems and as information and communication infrastructure with citizens and businesses (property tax systems / based on the size, status and location of a property, interactive zoning plans, e-grievance tools).

10 Pfeffer developed this tale, inspired by Rakodi 2003.

Empirical examples show that these kinds of application are largely fed with official codified-knowledge sources such as national census databases, infrastructure maps or sensor information, with a bias towards 'linear' scientific processes of generating sector-based knowledge on the urban environment. Recently, these "…'clean', well-behaved data that are amenable to analysis…" are complemented with "…'raw', less structured data such as mobile phone records, social media and other 'big data' sources" (Taylor, 2014: 3). Although a commonly used term for the conglomeration of the latter including a multiplicity of datafication processes is 'big data', we will not use this concept here. It refers to the automatic generation of data from the use of information and communication technology, rather than deliberately generated information derived from government (Census, surveys, etc.), businesses (price information, company info), and civil society (information from community mappings) (Kitchin 2011; Batty 2013), which is the main focus of our work.

The point of view of producing objective and scientific knowledge for managing 'smart' cities is largely shaped by private sector agencies and industries developing GIS tools and software and more recently data scientists and consultants processing and correlating big data sources. The vision of the international GIS market leader ESRI, whose clients range from community organisations, academia, government agencies and independent research organisations to consultants and private sector firms, is that their technology is trustworthy and "enables organizations to create responsible and sustainable solutions to problems at local and global scale". (www.esri.com)

In addition to the technologies, there are a variety of established methodologies and spatial models for analysing trends and pressing urban issues like inequalities, lack of visibility, security, informality or environmental vulnerabilities, and producing planning documents and economic visions.

For instance, there are methodologies for identifying and classifying particular groups (people-based) or geographic areas (area-based), for instance, portraying the degree of deprivation and needs of the urban poor or deprived areas. These are often area-based approaches using different methodologies, such as composite indices based on a variety of statistical and multi-criteria analysis techniques (index of multiple deprivations; socio-economic index), image interpretation using spatial indicators like density, regularity etc. or participatory and community mappings (see e.g. Sliuzas, 2004; Chambers, 2006; Lemma et al. 2007; Baud et al., 2008; Martinez, 2009; Baud et al., 2010; Patel et al., 2012). The framing of urban issues and their mappings may be underpinned by theoretical considerations, determined by conceptual models and standards derived from professional experience, or they can be the result of a data-driven algorithm (Martinez et al., under review).

Mapping initiatives to acquire and monitor urban resources result in cartographies of distributions. While poverty maps show distributions of areas with differing degrees of needs, land use maps provide a spatial imagery of what is where and what is envisioned to be were, employing cartographic practice for economic visioning (Gabriel, 2013) and visual representations for imagining future urban forms (Perkins and Dodge, 2007). Similarly, hazard and risk mapping methodologies classify the urban area in zones with varying degrees of vulnerabilities, ranging from scientific methods employing process-based or conceptual models for identifying hazardous areas, to unravelling local knowledge based on experiences or risk perceptions (Jameson, 2014; Filippi and Hordijk, forthcoming).

Processes of producing, using, and exchanging knowledge sources

Accurate, local-level GIS data are critical for creating sector-based knowledge on the urban environment. However, in many cities in the global South, local-level GIS databases are still in the making (Richter, 2014) and the local capacity for managing and maintaining such databases or the willingness to participate in database construction is limited. Priority is given to the development of those databases that will lead to an increase in efficiency and increasing revenues, such as the digitization of property tax. In many cases, sector-specific spatial databases which are in place are often not shared with other municipal departments, while these departments could make good use of spatially-based information to improve policy in the area of urban amenities (education and health), infrastructure upgrading or prevention of violence and crime. Furthermore, systematic acquisition and analysis of socio-economic and demographic information is seldom done, although these could be used effectively in monitoring spatial inequality (Martínez, 2009) and urban governance (Baud et al., 2008), as well as building information systems to inform public policy and support civil society action (Torres, 2008). For socio-economic and demographic information, local government often rely on statistical information provided by the Census, collected every 5 or 10 years. Though very informative, the census loses its validity over time, and trend analysis needs to be complemented by alternative demographic data which could be derived from birth registration, school subscriptions or lifestyle data.

Analysing high-resolution remote sensing images (Quickbird, Cartosat or Ikonos) of different moments in time can potentially fill knowledge gaps in GIS databases and also produce relevant base layers (e.g. land use maps). Although such images are already very interesting in themselves for monitoring land use changes or exploring known and unknown areas (e.g., with the launch of Google Earth millions of people located their own house), their strength lies in their ability to be combined with other data sources including expert knowledge, field observations and local/social knowledge. This enables the triangulation of the subjective process of interpreting and codifying the displayed information with other ground-truth data. When delineating and labelling areas on the basis of physical characteristics in the visual interpretation of time-bound images, place-based social knowledge (tacit or community-based) is indispensible in the interpretation and classification process. Such knowledge can be acquired in different ways; by means of participatory processes, for example, as experimented with in the delineation of slum settlements in African cities whereby citizens created the physical criteria of what would determine a slum in the local context (Sliuzas, 2004; Lemma et al., 2007). Knowledge can also be acquired by means of semi-structured field-surveys and qualitative interviews, for instance utilized by Baud et al. (2010) for identifying sub-standard housing areas or other ground-truth measurements.

Relying on (official) GIS-based 'technical' knowledge, often considered the 'truth' since it can be quantified, is problematic, because the data can only show what has been put into the system. Certain areas and people within a city may be left out or erased by the process of digitization (e.g. in digital cadastres), or seem not to exist because they have never been included in that that does not appear in the master plan of Chennai 2025 (Benjamin et al., 2007). This shortcoming is to some extent addressed by participatory GIS, which recognizes the potential of GIS for making alternative knowledges visible, shifting its role from being exclusively the domain of GIS experts and professionals towards an enabling platform for social knowledge construction. PGIS, or public participation GIS (PPGIS) can be used if integration of the public in planning and decision-making processes is sought (see e.g. Schlossberg and Shuford 2005). This employs a variety of participatory data collection methods adapted to urban contexts and integrated into the GIS technology environment (see e.g. Joshi et al. 2002; Hoyt et al. 2005; Sydenstricker-Neto 2008; Cinderby 2010). The definition of PGIS by Hoyt (Hoyt et al. 2005, p. 1) acknowledges that it is a combination of a

> "computer-based information system with an interactive human process which facilitates collaborative planning efforts, but its ability to effectively empower participants is largely determined by the local context—that is, the social and political relations that link or divide individuals, groups, and institutions".

This definition recognizes the double focus needed to make a computer-based information system really interactive. It implies that equal attention needs to be given to the context within which participatory knowledge management plays a role in decision-making, as well as the limitations set by social and political structures and relations between the actors involved (both empowering and controlling).

The various forms of PGIS in practice differ in the way that participation takes place and who participates (Sieber, 2006). A first approach consists of GIS utilization by communities with associated training to be able to apply GIS in their daily work practices. A second common mode of PGIS, especially in developing countries, is community participation in inputs and outputs, i.e. people contributing to the production of spatial knowledge and verifying outcomes. Originally, this was mainly applied in natural resource management (e.g. Craig et al., 2002; Sydenstricker-Neto et al., 2004; Wright et al., 2009), but has also been applied in the urban context (Ghose 2003; Sliuzas 2004; Elwood 2006; Pfeffer et al. 2011). Community mapping is another form of participatory spatial knowledge production which empowers communities, to make their voices heard, to reach the hard-to-reach and to create a database for social mobilisation (see e.g. Joshi et al. 2002; Hoyt et al. 2005; Cinderby 2010).

In recent years, with the exponential growth of geoICT and the increasing awareness of space and geographic location, non-geographic sectors, other disciplines and a variety of social groups including community organisations are also discovering the potential of GIS to making certain kinds of knowledge visible, providing means to question official knowledge sources. This led to a new strand of participatory knowledge production in which users generate content on a voluntary basis, also called volunteer geographic information, neogeography, wiki-mapping or Geoweb (Goodchild, 2007; Martínez et al., 2009; Elwood, 2010; Georgiadou et al., 2010;). The 'democratization' of technologies for producing, using and exchanging knowledge and its self-organizing nature, facilitated by the exponential increase of location-based services and GPS-enabled mobile devices, has opened up new opportunities for urban analysis and starts changing the socio-political construction of spatial knowledge (Elwood, 2010). Examples are the Ushahidi platform (http://ushahidi.com) or the Argentinian project on checking and opening up government data (http://chequeado.com). Using location-based mobile

devices together with web-mapping and other interactive websites (Web 2.0) or virtual globes, has the potential to complement technical knowledge. They also offer interesting possibilities for organising knowledge spatially and create an interface between different actors (e.g. public sector and citizens or communities) for knowledge production, verification and exchange, assuming internet access and digital literacy (Hardey 2008; Bugs et al., 2010; Georgiadou et al., 2010; Hall et al., 2010;).

While mobile phones provide low-key means for recording and informing about the malfunctioning of services, including their geographical position, and other activities, ICT-based initiatives remain local and lack the up-scaling to either city level or national level, which could make them comparable and possibly provide consistency across scale levels. Moreover, this form of ICT-based knowledge construction suffers from uneven development in terms of data production and uneven access by the public to such tools and will therefore, by itself, not be inclusive (see e.g. Graham, 2011 on the digital divide). More recently, claims are made that new data sources such as mobile phone records, social media data and sensor measurements also provide interesting insights, despite their uneven coverage and questionable reliability (Kitchin, 2013).

The most transformative form of participatory knowledge generation is counter-mapping, that is, "mapping against dominant power structures, to further seemingly progressive goals" (Hodgson and Schroeder 2002). Counter mapping is the "appropriation of state technologies and official practices by everyday communities to use to their own ends (Gerlach, 2014: 32). Counter-mappings initiatives by a variety of interests provide alternative views on the 'official' knowledge (e.g. produced by the state/city) and make the silences and blind spots on a map visible (Wood, 1992; cited in Kitchin and Dodge, 2007; Crampton, 2009). It also produces knowledge that is used to resist and develop counter-arguments. In distinction to counter-mapping, Gerlach (2014: 33) states that 'vernacular mapping' is a new practice of mapping that shows a shift from a concern with "the representation, identity, essences and static beings to one animated by imaginations, affect, events and becomings". As such, vernacular mapping offers a tool to think about possibilities or potentials (Gerlach, 2014). OpenStreetMap is an example of collaborative mapping. The present shift towards the democratization of mapping tools and spatial information is a fundamental characteristic of this approach. Also civic mapping (Scott and Barnett, 2009) could serve as or be classified as counter mapping as an advocacy tool but not necessarily. It only becomes counter mapping as it is used to confront or challenge another map produced by a different social group. In South America, GPS technology has for instance helped Amerindians to claim historical territories (Poole, 1995), and in South Africa GIS was proposed to re-draw the maps of apartheid (Peluso, 1995).

Overall, spatial knowledge tools, although originally designed for spatially accurate datasets from official sources (McCall and Dunn 2012), offer a variety of possibilities to derive, produce, consume and share (participatory) spatial knowledge and provide a mixture of different kinds of knowledge pertaining to the same locality, making it possible to link more qualitative, tacit kinds of knowledge (from groups in local communities), to more technical knowledge production at local levels (e.g. Clark and Dickson, 2003). In Indian cities, the idea of community 'census' mapping in Mumbai and Pune has provided information on slum communities which was much more valid and reliable than the assumptions made by city planners (Joshi et al., 2002, Patel et al., 2001). Scott and Barnett (2009) describe the ways in which residents living around a refinery in a South African city produce scientific information on air pollution and pollution complaints as a form of 'lay science', which provided an acceptable form of scientific knowledge in urban planning discussions.

When recognizing the sensitivity of the local context, spatial knowledge tools may potentially be valuable for legitimizing, analysing and representing local knowledge, values and priorities (McCall and Dunn, 2012). However, the usefulness of spatial knowledge derived from various (technical) sources also depends on timeliness, reliability, accessibility and the ability of the various actors to understand and use them (Kyem and Saku, 2009). Further aspects of concern are the uncertainty and the simplification of spatial knowledge (phenomena depicted as geometric features in space), and the opaque processes of web-based services that may favour certain kinds of information (Hardey, 2008) or have unstated social implications (Elwood 2010). Drawing a sharp boundary to define borders may generate a conflict, which is not there on the ground (Dunn 2007). In addition, marginalization and exclusion may result from the dependence on ICT and the internet as a knowledge management tool.

The challenge is how to incorporate knowledge sources, ranging from volunteer efforts to more deliberative processes of being involved in the decision-making processes, and how to translate and upscale qualitative knowledge into GIS as the language of planning and decision-making (Dennis, 2006). Moreover, despite of the widespread use of GIS and multiple mappings produced, one needs to be aware of the critique of the implicit assumptions with respect to the knowledge sources used and classifications made. Specifically, spatial knowledge

development and diffusion builds physical limits, and borders and locations have a strong effect on the reality reflected in maps. Caution needs to be exercised when the map becomes the reality and its borders and elements become used for the identification and differentiation of different interest groups, a process which can potentially fail to reflect opposing group interests.

Transformative potential–problematics of geographic information technologies/maps

Producing spatialised knowledge is an important advance in the discussion of urban inequalities and measures to produce more sustainable/resilient development in cities, because it makes visible local variations in inequalities. In deliberative processes, the addressing of particular issues could then be undertaken through joint prioritisation processes (e.g. Hoyt et al., 2004; Ghose, 2007). This potentially allows targeting of resources and reduces the costs of addressing inequalities. Potentially, it could also lead to more transparent decision-making, if such spatialized knowledge is embedded in deliberative processes supporting (participatory) decision-making in urban areas.

Spatially disaggregated knowledge in urban governance is usually delivered by expert GIS systems. The software programmes for GIS are not generally accessible to lay people, and even urban government staff find them difficult to deal with (Pfeffer et al., 2012). This has meant that spatialized knowledge is not used widely, and innovative ways of inserting different types of knowledge into GIS is still in an infant stage (cf Sliuzas, 2003). Part of the reason for this lack of information for GIS is the requirements for entering spatial information into GIS, which requires exact geographical locations for the information provided in order that it can be mapped. This tends to favour expert scientific quantitative knowledge over local qualitiative knowledge.

Currently, in urban governance processes, the use of spatially disaggregated knowledge is often used internally (within government) as a management information system (MIS), and externally for disseminating information to citizens (improving administrative efficiency), and sometimes for improving performance (e.g. in tax collection) (G2G and G2C). In e-grievance redressal systems, governments create structured spaces to receive information from citizens about the malfunctioning of provided services in specific localities in order to improve response time in addressing issues in service delivery (C2G) (Martínez et al., 2011). In this way, local government could show (if technologies communicate) where the problem areas are and how complaints have been addressed.

Spatially disaggregated knowledge can also be used for more transparent political discussions and priority setting, by including local community knowledge or other information from existing databases (Census, surveys, remote sensing and Google Earth) to give priority to specific dimensions of sustainable development, and identifying geographic areas where the needs are greatest (hotspots) (Joshi et al., 2002; Baud et al., 2008; Pfeffer et al., 2011) (C2G or C2C). In several empirical cases this been put into practice by providing an interface, often in the form of a webpage, with or without GIS functionality, for facilitating spatial information exchange or one-directional provision of information (e.g. Kingston 2007; Martinez et al., 2011).

Using spatially disaggregated knowledge in G2G, G2C and C2G interactions is becoming more common among city governments in the global South; in contrast, utilizing spatially disaggregated community knowledge to address needs in a more integrated fashion is still rare and usually contested by governments except in special project circumstances (Joshi et al., 2002; E&U, 2012: special issue). Some examples exist of experiments where local or individual knowledge of localities has been mapped in GIS systems, such as in Pune, India. However, these examples usually occurred with the help of experts familiar with GIS software.

Another major question raised within the digitization and spatializing of information and knowledge debate are whether this empowers citizens (promote transparency and accountability) or whether such tools increase the levels of surveillance on citizens (reduce corruption opportunities and political freedom). In the North, the increasing surveillance of citizens is considered a strongly negative phenomenon, which is also being increasingly seen in the South; in the South the weakness of the state might be reduced by more effective monitoring systems that reduce corruption opportunities and strengthen state competencies within their mandates. Spatial and digital literacy and having access to the ICT-based systems may empower the 'elite' being included in the information and knowledge revolution and not the wider group of 'uninformed, labouring participants' (Graham, 2011; Haklay, 2013), exacerbating social and spatial inequalities instead of reducing them.

Finally, maps as products have a transformative potential. The way that urban issues are framed and what classifications are used, both in input and output lead to different mappings and outcomes, and thereby may have positive or negative consequences for those affected. Examples are redlining practices, where mortgages may be denied to people living in a disadvantaged area (Aalbers, 2005); mapping informal areas listed for eviction; or

ignoring particular groups or phenomena in standardized land use classifications or mapping processes (e.g. risk mapping affecting insurance premiums).

Link to empirical analysis

For our empirical analysis we follow Kitchin and Dodge (2007) and Kitchin et al. (2013) who suggest a shift from ontology to ontogenesis, specifically a move from maps as secure products to how maps become and unfold in mapping practice. We prefer the processual approach because 1) it considers the multifarious, contingent and relational nature of urban life, 2) it opens up the narrow understanding of map making towards a broad set of spatial practices including sketch maps, counter maps and participatory mapping, and 3) it allows researchers to examine the effects of maps and mapping within multiple and shifting contexts, including an exploration of how maps and mapping processes work ('what they cause'), how they are reworked and what power they exercise.

Example of a mapping process (based on Kitchin and Dodge, 2007)

'…maps *emerge in process* through a diverse set of processes' (Kitchin and Dodge, 2007)

Most larger local governments have a mapping or IT unit, which produces geographic knowledge, often as visual representations like maps and graphs, for urban decision-making, policy-formulation and management. For instance, in order to invest in a certain geographic area, the mapping unit may get the request to produce knowledge on the geographies of multiple deprivations to target those most in need. The spatial representation of that issue needs to comply with agreed conventions and standards, based on data which effectively communicates varying degrees of deprivation across geographic areas. The main ingredients for the mapping task are specialized tools to measure multiple deprivations and software, geographic boundaries to which appropriate data are matched, earlier mappings produced and the available degree of knowledge, skills and experience for the given task. The mapping process and its product, a cartographic distribution in terms of multiple deprivations, is shaped by several choices concerning the type of boundaries used, allocation of population data to the boundaries, thematic classification, colours and shading, labels, placement of map elements and so forth.

All decisions and actions of the mapping process 'grow' the map. Although printed maps in reports often seem to be "immutable mobiles, that is stable and transformable forms of knowledge that allow them to be portable across space and time" (Latour, 1987) maps are becoming into being and are remade every time they are used and engaged with (Kitchin and Dodge, 2007). The deprivation map is coming into being by those reading the map, interpreting it, relating it to other spatial imageries (tacit knowledge, mental maps), maybe asking for a revision, taking action, and thereby shaping urban space. Accordingly, that particular map is made anew emerging from the intersection of the knowledge, skills, experience of a map viewer to understand the cartographic language of a map, the information communicated by the cartographic representation, the interest of a map viewer, but also the actual material geography on the ground. In order words, all spatial things together, different types of knowledge and observation are folded into each other to make sense of the urban space and bring it into being. The information conveyed by map, i.e., varying levels of deprivations across geographic space, may become a collaboratively produced set of maps through further discussing the issue and its spatial representation in a workshop; each workshop participant will produce her/his own spatial imagery of deprivations in the given geographic context. Maps may also be rewritten by adding new features and drawings on existing representations, for instance putting emphasis on a certain area, drawing an arrow or adding photographs to include context information. All things and activities work together, linking a spatial representation of deprivations to actual material space and thereby multipling and traversing the urban landscape of deprivations.

2.4. Outcomes: Participatory spatialized knowledge management; transforming urban governance and outcomes?

This brings us back to a more specific discussion on how participatory spatialized knowledge can be brought into decision-making processes in urban development. How is it valued (or hidden and ignored), exchanged or contested, and whose knowledge is included or excluded? What methods exist to include participatory spatial knowledge production and utilizisation in such processes, and how can they be made more inclusive? Structure of this section?

This question is multi-dimensional. To begin with, the different types of urban networks or regimes influence the extent to which participatory spatialized knowledge is accepted in urban decision-making have to be distinguished. Basically, two major types of networks are recognized;

(1) those of city governments with private sector actors (developers of various sorts) dealing with city development in economic development, housing and infrastructure (Rydin, 2007), and (2) the city government-citizen networks dealing with the quality of life issues brought forward by groups within the city, particularly inequalities and poverty experienced by large numbers of residents. A great deal of literature on this subject exists (e.g. Baud and Nainan, 2008; Miranda and Hordijk, 2001). An interesting recent addition in this respect is the focus on multi-scalar networks (e.g. relations between different scale levels of government; or social networks working at local, national and international levels), or cross-boundary networks (e.g. city-to-city cooperation by local governments, by slum dweller networks; regional cooperation in economic development by local governments such as Santo Andre in Brazil) (Barnett and Scott, 2007b; Paredes et al., 2008).

The character of such governance networks differs according to the basic organizing principle, which sets the boundary conditions for the types of knowledges produced and the ways in which such knowledges are exchanged (network, market, hierarchical). Puri and Sahay (2007) suggest that participatory spatial knowledge production and exchange is based on firstly, social and political relations, which show great inequalities in political power, capabilities of participation and the ability to define agendas, and secondly, a range of institutional conditions, which allow for effective participation[11]. They attempt to synthesize the issues around participation from both the internet studies and development studies literature in order to identify four key problematic areas: viz., "(a) who defines the participation agenda, (b) what capabilities do stakeholders have to participate and how can this be strengthened, (c) what is the role of institutional conditions in enabling effective participation, and (d) how do local participatory experiences get integrated into broader networks to become sustainable" (2007: 142).

The discussion will now turn to the issue of the role of institutional and social structures, and our final research question: what difference does the utilization of such participatory spatialized knowledge management make to decision-making outcomes?

11 This implies that our analysis needs to include several scale levels: (1) the extent to which computer-based information systems work as information systems, (2) who defines the agenda of participation and change, (3) the capabilities of the stakeholders in the decision-making processes and their strengthening, (4) how are local participatory experiences integrated into broader networks of participation, and (5) what support or constraints do local institutional conditions set?

As indicated earlier, the ideas behind urban governance networks implicitly suggest that they provide more space for including and recognizing other types of knowledges in decision-making processes, in which the participatory inputs from residents, slum residents, NGOs/CBOs have become part of a priori accountability in some countries and cities, depending on the political context. Brazil is an example of a country with institutionalised participatory budgeting processes. The examples from South Africa and India indicate that political strength is needed by the actors producing alternative community-based knowledge to ensure that it is recognized and utilized within the planning process (Patel et al., 2001; Joshi et al., 2002; Scott and Barnett, 2009). The extent to which participatory planning and management is anchored in a legal framework makes a significant difference in making inclusion of knowledges effective. Ackermann (2004) indicates that such legal frameworks are essential for the mandates of participatory processes to be given legitimacy. This is demonstrated by the firm embedding of participatory processes in Brazil (Gurza-Lavalle et al., 2005). Gaventa (2006) indicates the necessity of a democratic context in which such processes gain legitimacy and wider acceptance. Local government needs a mandate, provided by legal frameworks, as well as fiscal decentralization and earmarked funding, which strategically support for participatory processes. The influence of various external conditions on the extent of participatory governance has not yet been analysed much locally and certainly not comparatively across different socio-political contexts. This is a strategic research question, given the inherent trade-offs and potential political conflicts in combining environmental, social and economic goals to ensure future sustainability in cities.

This brings us to the final question of how the ways that knowledge is sourced, constructed, utilized, and who is involved is transforming and affecting the outcomes in urban development processes. This is a normative question, the outcomes of which aim to contribute to sustainable development in cities. The criteria for assessing the outcomes of urban planning and management processes are defined by the domains which we propose to analyze within our project, namely, economic growth and diversity, reducing social inequalities and vulnerabilities, and increasing environmental sustainability, supported by decentralized and more participatory fiscal flows. These domains are brought together through the lens of digitized and spatialized knowledge management configurations, which have the potential to build capacities for 'new sustainable' urban development.

This research project is specifically interested in how spatialized knowledge is constructed and produced by state and non-state actors, residents and users of the city, and

the extent to which such knowledge reflects inequalities in economic opportunities, the living habitat and livelihoods of vulnerable groups in the cities concerned, environmental hazards they face, as well as their priorities in collectively organizing to counteract such vulnerabilities (e.g. Ghose 2007). Discussions on urban 'riskscapes' show how knowledge of risk is constructed in specific contexts through the experiences of people, not necessarily leading to mobilisation (Brooks et al. 2010; Moser 2011).

We conclude the discussion above by drawing out the main points on knowledge and urban governance processes which are taken up in Chapter 4 recounting the results of the cases studies in seven cities of our project. The first point is that knowledge construction and the actors recognized as legitimate in such construction vary widely by approach and also by domain of concern. The second point is that sourcing knowledge from a variety of people, institutions and scales is more likely to reflect the diversity of urban experiences and priorities for change than when monolithic approaches are utilized. The question is to what extent such knowledges are recognized as legitimate. A third point is the question of how permeable boundaries are between institutions and epistemic communities in allowing other sources of knowledge and paradigms to be included in discussions around urban development. The level of contestation and the political processes to cross boundaries is an important issue to investigate. Finally, the question is how knowledges included in urban governance processes affect outcomes, particularly in terms of existing inequalities and sustainability of urban development strategies.

3 Conceptual Framework and Methodology

3.1. Spatial Knowledge Management Configuration (SKMC) as Conceptual Framework

This section presents a summary of the analytical framework for Chance to Sustain and focuses on the concept of the SKM configuration. The framework was developed collaboratively through an iterative process of literature review and empirical evidence in a number of workshops with members of the research team. The section first presents the location of the project in the 'new' concept of sustainability; it examines the concepts related to 'sustainability transitions' and then focusses on the concept of the SKM configuration. The question is then posed regarding what adaptive capacity is evident within cities within the configurations which can provide a basis for greater sustainability in cities.

Since the main question of the Chance2Sustain project relates to understanding the role spatial knowledge management could play to enable cities to move towards a more sustainable future, it is therefore critical to interrogate the concept of sustainability. The C2S project is located within the 'new concept of sustainability' which has emerged in the Anthropocene, a new epoch in which it is declared that one species (human beings) has become the driving force of change (Bierman et al, 2012; Lorimer and Driessen, 2013). This concept is also a response to the economic uncertainties and socio-economic issues that have emerged in the post-2008 recession period which are referred to as the 'polycrisis' (Swilling and Annecke, 2012). The 'new' concept of sustainability retains the norms and values of the concept of sustainable development and therefore accords great importance to the "over-arching, symbolic role–of aspirations, visions and normative commitments–that remains so politically potent" (Scoones 2007, p. 594). Furthermore, the 'new' concept of sustainability proposes conceptualising current realities as a set of intersecting ecological, economic and socio-political domains with local and global dimensions. It stresses the interconnections, intersections and entanglements between environment and development (human, economic and social processes), and the overlaps and interdependencies among these domains. It calls for the adoption of a *multi-scalar and long-term* perspective to understand local and global dimensions. It proposes that different paths and patterns of sustainabilities are negotiated in specific urban contexts: it is "a general, pluralistic, open principle that allows for many different solutions to be democratically discussed and acted on (Arias-Maldonado, 2013, 430).

We therefore understand sustainability from a constructivist perspective as a long-term multi-dimensional

and multi-scalar process driven by socially negotiated and potentially contested or antagonistic visions, goals and values. We consider that questions of sustainability must be articulated with key political questions about who (or what) gains from practices and policies implemented under the label of 'sustainability', who benefits from or are excluded from them, and what arrangements and strategies can be conducive to enhance the democratic content of decision-making linked to sustainability policies (Shove and Walker 2007, Swyngedouw 2010). Our understanding pays particular attention to contextual differences.

Processes towards more sustainable forms of development, whatever definition has been adopted, are often framed in terms of 'transition' – broadly defined as "a substantial change and movement from one state to another" (Shove and Walker 2007, p. 763). The emerging fields of 'transition studies' or 'sustainability transitions' provide a rich theoretical discussion on sustainability and governance (Markard et al. 2012, Frantzeskaki and Loorbach 2012) which we have drawn upon to develop an analytical framework for answering the main research question. While we adopt a different perspective in terms of our epistemological position, object of analysis and approaches, we share a number of positions that have recently emerged as part of the critiques in these fields (Shove and Walker 2007, Meadowcroft 2011), particularly around issues of agency, power and politics and governance. More recently, some strands of this literature have focused on sustainability transitions at regional and local scales (Spira et al. 2014, Egermann et al. 2014), and more specifically on cities and urban settings (Bulkeley and Castan Broto 2013). This strand of literature on 'sustainability transitions' acknowledges that governance plays a particular role in transition (Smith et al. 2005). Within this literature 'sustainability transitions' are defined as "long-term, multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption" (Markard et al. 2012, p. 956). A system is here defined as a network of actors and institutions, material artifacts and knowledge. Elements of the socio-technical system are inter-related and interdependent (Markard et al. 2012).

When addressed more broadly, transition approaches conceptualise sustainable development as "an open-ended process of societal change that entails values of ecological integrity and protection, and intergenerational justice and responsibility" (Frantzeskaki and Loorbach 2012, p. 32). Transition assumes the following: far-reaching changes; different dimensions; a broad range of actors; and impacts on related societal domains (living, housing, working, planning, and policymaking). In addition, 'transitions towards sustainability' differ from other historical transitions in that they are 'goal-oriented' or 'purposive', that is, they seek to address specific problems, they require changes in economic and political frame conditions (in order to allow innovations to take place and replace existing systems) as well as strategic reorientation of actors, which defend existing systems and regimes (Geels 2011, p. 25).

The sustainability literature stresses the importance of governance as it is through governance processes that sustainability challenges will be met. This raises the question of the extent to which knowledge management (KM) within urban governance is becoming transformed; digitized through the use of ICT, ***spatialised*** through the use of geographic information systems (GIS), and to what extent knowledge management incorporates ***participatory processes***. We use the concept of *'SKM configuration'* to capture the important combination of elements that contribute to urban development decision-making and outcomes in the social, economic and environmental and fiscal domains with specific reference to the knowledges produced, exchanged and used in these processes, which we are analysing in specific urban contexts/cities in the South. This concept combines various dimensions and processes. These include: first, the discourses and framings concerning its potential, second, the actor networks that drive spatial knowledge management producing and their power relations (sharing, exclusion); third, how socio-spatial knowledge is produced, including the types of information and knowledge that form part of this configuration, exchanged and contested as it becomes embedded in decision-making processes; and fourth, the materialities of such spatial knowledge management, including the databases, programmes, and platforms. Finally, analytically separate but integrally linked, the way KM influences work practices and outcomes needs to be analysed[12].

Therefore, more precisely, we define a spatial knowledge management configuration (SKMC) as an arrangement of 1) discourses and framings about spatial knowledge management, 2) a set of actor networks and coalitions including their power relations, 3) the knowledge building processes, exchange, contestation and use digitized spatial knowledge, 4) the spatial knowledge platforms and products (ICT-GIS-based products; maps) and as a separate but necessary dimension a discussion of the outcomes of using spatial knowledge in urban development processes (cf. Pfeffer et al. 2013; Baud et al. 2013; van Buuren 2009). Because knowledge management configurations do not always include spatial dimensions, we also draw on more general definitions found in the literature on knowledge management systems (see literature review WP5, 2011; van Buuren 2009; Feldman et al. 2006).

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We focus in this report first on the spatial knowledge management configuration in which local governments play a steering role, both within government itself (G2G) as well as in relation to their citizens or from citizens to government (G2C, C2G), including how knowledge institutions and civil society work with governments in inserting tacit, codified and contextual-embedded knowledge into governance processes[13] (chapter 4).

We then focus on how spatial knowledge management is embedded in the other strategic domains identified in this research project and to what extent it has brought about strategic changes in the way those domains function (chapter 5).

The extent to which the SKMC are participatory and interactive is a question split into several sub-questions: (1) which actors are included in the various KM processes and who are excluded? (2) What types of knowledge can other actors potentially include – particularly, forms of contextual-embedded knowledge?[14] (3) What kind of access and ownership of knowledge do actors have (transparency, empowerment, accountability)? And (4) how does the participation of other (civil society) actors in particular change the outcomes of urban development?

We are mainly interested in the ICT-based KM systems because of the transformatory potential attributed to them. We are specifically interested in the introduction of digitized information, electronic platforms (including mobile phone networks), and GIS-based systems (mapping) into departments of (local) governments and other organisations, and to what extent such spatial knowledge management activities become integrated within and across organisations. This is essential because across the world ICT-based data and spatial data infrastructure is being set up to produce geographic and thematic information, as well as to co-ordinate knowledge exchange within and between organisations in re-engineering their work processes and negotiations for future change (Mayer-Schonberger and Cukier 2013).

From our perspective, the production of knowledge is a relational process, where power, internal capacity and competency issues and external competition may hinder straightforward knowledge exchanges (e.g. Giezen, 2012; Healey 2007; McFarlane 2006). The process of knowledge production involves both internal organisation and relations with other institutions, as well as the extent to which ICT-GIS-based products are produced and introduced into various work processes. We use the term ICT-GIS to describe a variety of products which are based on ICT modes of communication (internet, mobile phone) and which have a spatial dimension (geographic coordinates, maps, geographic visualisation).

We also focus on the extent to which the introduction of ICT-GIS-based knowledge management impacts on the outcomes of the processes into which they have been introduced around urban development[15]. These potential outcomes include *greater respect for rights and entitlements, competences (and legitimacy) in (local) government, increasing transparency and accountability towards citizens* (cf. McCall & Dunn, 2012). Similar potentials are suggested for contextual-embedded types of knowledge, particularly when it concerns community-based knowledge. In this report, we examine the extent to which such potential is realized in the context of local government as the main actor in urban development, working with other actors in the private sector, civil society, and citizens directly. We examine to what extent SKM has changed outcomes; (1) by addressing new types of complexity, uncertainties, and stresses (transition and transformation), (2) by increasing transparency and accountability towards citizens, and (3) by building adaptive capacity through reflexive and interactive knowledge management.

Our assessment of such outcomes is set against the background of specific city contexts, in terms of historical trajectories and geographical contexts (agglomerations, regional hubs, capital cities) and the national policies which shape existing social contracts between government and citizens. Together they will allow us to understand the potential adaptive capacity of the cities concerned through their build-up of SKM in the various strategic domains.

In summary, the C2S project focuses on *governing from a knowledge perspective* as the main cross-cutting questions of the research. We therefore apply the concept of a *knowledge configuration* to partly examine the use of knowledge in governance (across the domains). The project has developed an *analytical framework for understanding the knowledge configurations* related to the processes of governance that aim at addressing issues of economic growth, socio-economic inequality, and environmental sustainability, with a focus on water-related issues. The configuration concept is therefore our way to encapsulate

13 For a definition of tacit, codified and contextual-embedded knowledge please refer to section 2.1. Table 2.1

14 For literature on these issues, see also McCall and Dunn, 2012; McCall, 2011; Verplanke et. al, 2010; Miscione et. al, 2011.

15 These can include planning processes, administrative processes, interactive processes providing feedback from citizens, and CSO-based construction of community knowledge (cf. Pfeffer et al. 2012).

all elements to assess particular arrangements and transitions, and issues where urban development decision-making is taking place across the domains.

Governing the present and the transition to the future means looking at *building capacities* for reflexive learning (based on knowledge building processes) to achieve a different relationship between environment and development (with the emphasis on the role of human endeavour) which is designed to make cities more sustainable as an outcome. Thus, we ask the question of what capacities have been built up, and embedded in specific arrangements, that allow cities to develop practices that support urban, socio-economic and environmental change according to locally negotiated conceptions of sustainability? It is also important therefore to ask: what are the arrangements that might prevent this from happening, and what are the limitations and constraints that cities are facing in developing such practices?

We therefore examine what *capacities* are evident in the governing processes covered in the various domains. What are the capacities that have emerged and are emerging to achieve a different relationship in contrast with 'business as usual' (the dominance of the economic growth)? The central question that needs to be addressed when dealing with capacity is the following: *capacity of what/who for what/whom and with which effects?*

In our analytical framework 'capacity' is conceptualised in relation to the notion of 'configurations' and in close connection with knowledge production, exchange, contestation and use. It is linked to two central aspects of our analysis: our approach to *governance* (inclusive, participative, reflexive, and interactive) and the *long-term goals of sustainability or the transition towards sustainability addressed at the urban and more global level*. In our understanding, *building capacities* means building different types of knowledge as our main focus, accessing resources in a generic way, considering inclusion and exclusion of actors and knowledge, taking into consideration structural constraints.

3.2. Methodology

Sampling of case study cities

The Chance2Sustain project is based on a comparative analysis of 10 cities[16]. Our analytical selection consisted of middle-sized, fast growing cities from mainly BRICS countries with populations between 1-5 million[17]. These cities are fast growing with relatively low levels of funding and spending; they have high proportions of people living below the poverty line, as well as high levels of inequality (*High Gini index in South Africa, Brazil and Peru, and moderate in India*), low levels of basic services and high levels of need. They are also characterised by large areas of sub-standard settlements (*share of the households living in informal settlements*) as significant features of the city (Table 3.1).

The results from C2S show that there is currently a highly unequal exposure to risks, stresses and injustices in the urban context:

- The cities face different levels of historical injustices in different domains
- They experience the issues of sprawl and compactness in development processes in different ways
- The cities have different physical settings, issues of degradation and levels of natural restoration and protection
- Cities are faced with an urgency to act to address short-term issues versus taking a long-term perspective

In addition, the cities show different institutional arrangements linked to various forms of the scaling and rescaling of governance. There also exists in the cities different expressions of democratic processes; and the fragility of institutions varies throughout them. There are tensions *between* neoliberal pro-growth and pro-poor social development policies and practices which are expressed and traded-off differently in each country depending on the historical, spatial and political economy context. The aim of the Chance2Sustain project is to compare the ten cities utilizing a comparative approach.

16 We gratefully acknowledge the funding provided by the EU 7th Framework Programme under project no. 244828). Project Partners in this project are the European Association of Development Research and Training Germany; Amsterdam Institute of Social Science Research University of Amsterdam (The Netherlands); French National Centre 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/

17 When this project started, Chennai was still a city of some four million people. Because of boundary changes, that has since jumped to eight million (Census 2011).

Table 3.1: Characteristics of case study cities

	Pop. Growth rate 2000-2005	Pop growth rate 2010-2015	Gini coefficient (country)*	% hhs in urban slums
Durban	2.1	1.7	63.1 **	33.3 ***
Cape Town	2.6	1.7	63.1	6.1 (Western Cape) ****
Guaruhlos (SP)	2.9	1.4	54.7	16.54 ******
Rio de Janeiro	1.2	0.9	54.7	21.78
Salvador	2.3	2.6	54.7	20.59
Lima	2.1	1.9	48.1	33.33 *******
Arequipa	2.1	1.8	48.1	30 *******
Kalyan Dombivli	n.a.	n.a.	33.9	41.3 (Greater Mumbai)
Chennai	1.7	3.0	33.9	28.5
Delhi	2.7	3.1	33.9	14.7

* Figures are from 2009, 2010 (WB); figures on growth rate 2010-2015 are from World Urbanization Prospects revision 2011, and from 2000-2005 from the Revision of 2007; % hhs in slums from Census 2011 for India:

** Bosch et al 2010 suggest that the Gini cooefficient for South Africa should be estimated at 59.0 when the social policy contributions of government to households are taken into account.

*** Based on an estimation in 2002 from Makhathini, M; Pather, C and Seedat, F (2002), *The eThekwini municipality's informal settlement programme An informal settlement free Durban in 15 years–Dream or reality?* Paper presented by the eThekwini Municipality's Metro Housing Unit at the Western Cape Provincial Housing Conference on 24-27 March 2002, Cape Town.

**** Based on government figures in table on this page: http://goodspeedupdate.com/2007/2123 Divided by the total population of 5.8 million of Western Cape.

***** Figures for Guarulhos, Rio de Janeiro and Salvador are based on C2S city report: http://www.chance2sustain.eu/fileadmin/Website/Dokumente/Dokumente/Publications/pub_2013/C2S_CR_No01_Urban-Chances-in-Brazil__V1-5.pdf

****** Estimation found on the page of Informal City Dialogues: http://nextcity.org/informalcity/city/lima Could ask for the sources where their estimation is based upon?

******* According to Imparato, I. & Ruster, J. (2003) *Slum Upgrading and Participation: Lessons from Latin America*. World Bank Publications.

The case studies are too extensive to include completely in this paper; the city reports for each case study city are available online at the EADI-Chance2Sustain website. Below the case studies covered are briefly set into their context (Table 3.2).

3.3. Comparative Approach

Of critical importance in the comparison of Spatial Knowledge Management Configurations across the cities is the need to consider the specificities of the historical contexts in order to provide "nuanced, complex, contextual accounts" (Robinson, 2011). Departing from the traditional positivist epistemology and resulting methodology of comparison, which assumes functional equivalence for generalisation, the C2S project adopts the *relational approach* instead, which accepts that complex territorial histories [re]produce the human geography of places in relation to one another and to a larger whole.

Based on the concept of relational space, it is assumed in this project that many urban phenomena are created by, tied into and shape sets of connections, which can be socio-

Table 3.2: City Contexts of case study locations

City	Main features of the context
Delhi, India	• Capital city / National Capital Region at its back drop • Pro-Growth agenda with megaprojects dependency • Spatial inequality and segregation • Centralised governance / alternative forms of public participation • Multitude of institutions and overlapping jurisdiction • Severe shortage of Water and Electricity, especially during summer • Pioneer in SDI with Act passed in Parliament. • Heavy dependency on the Central Government for financial needs
Kalyan Dombivili, India	• City in urban agglomeration • Pro-growth and pro-poor agenda • Spatial inequality between the two urban cores (Kalyan and adjacent Dombivili) • Municipal boundary restructuring • Institutional restructuring – improving local capacity • Improving service delivery, but still uneven • Pioneer in e-governance • Entrenched financial management
Chennai, India	• Regional hub – Metropolitan area and major port driven by IT-BPO and car industry • Pro-growth and pro-poor agenda • Corporation area expansion – change of municipal boundaries • Acute water, electricity and mass transport shortages • Pioneer in e-governance • Online bill & tax payment
Cape Town, South Africa	• Regional hub • Pro-growth and pro-poor agenda • Deeply entrenched spatial inequality • Post-apartheid context of transformation – legislative and policy reform • Spatial restructuring • Institutional restructuring – lack of capacity at local level • Good record of service delivery • Excellent financial management
Durban, South Africa	• Regional hub • Pro-growth and pro-poor agenda • Deeply entrenched spatial inequality • Post-apartheid context of transformation • Spatial restructuring – inclusion of large peri-urban area post-2002 • Institutional restructuring – lack of capacity at local level • Good record of service delivery • Excellent financial management

Table 3.2. continuation

City	Main features of the context
Lima, Peru	• Capital city and capital region • Pro Growth and pro-poor and pro life/green agenda in tension • Strong proceses of new megaprojects reconfiguring the city via public private partnerships • Centralization, complex and overlaped urban regime • Mandatory concertaci□n and participacipon processes • Dual, fragmented and segregated city • Highly vulnerable city, particularly to climate change • Unequal service delivery • Water stress, lack of green areas and public spaces
Callao, Peru	• City within Lima agglomeration • Pro-growth and pro-poor agenda • Legislative and policy reform; mandatory concertacion processes [1] • Institutional restructuring – improving local capacity • Social inclusion and public participation • Strong concentration of industrial-service sectors in region
Guarulhos, Brazil	• City in agglomeration • Pro-growth and pro-poor agenda • Spatial inequality and segregation • Spatial restructuring – inclusion of peri-urban/poor areas • Institutional restructuring – improving local capacity • High economic activity – services and industry • Social inclusion and public participation • Good record of service delivery • Good financial management

economic, political, and spatio-temporal. It is these connections, which we consider to be our unit of analysis. We believe then that cities have to be theorised as "open, embedded and relational" (Hart, 2002). This processual, interpretive approach draws on the recent work within the field of comparative urban research (Ward, 2006; Robinson, 2011a, 2011b; McFarlane, 2011; McFarlane and Robinson, 2012).

The emphasis on process and the multi-directional, co-constituted and emergent nature of the urban fabric means that scale is not cartographic but socially constructed. As such, the relational comparative approach (Ward 2008) is much more interpretive and qualitative in nature than the traditional approach. Using the relational concept of comparison means that we do not measure our 'cases' against a universal yardstick, but "consider both similar and different urban outcomes" (Robinson, 2011: 13). Particularly in the Chance2Sustain framework, which attempts to understand rapidly changing processes of development, the analytical level of the SKMC as a processual, relational approach is believed to have much greater potential to contribute to the theorisation of city transformations and transitions than using factual indicators for comparison. SKMCs provide an overtly political theorization of knowledge management in different historical and geographical moments as this approach explicitly examines the contestation over discourses that occur among actors and in urban development networks locally and globally. The conceptual framework of configurations can be interpreted as the analytical midpoint between assemblages and regime theory.

Comparatively, C2S examines spatial knowledge configurations across the strategic urban development domains of the study, namely, those of economic growth, social inequality and vulnerability, and environmental

governance. This provides an comparative understanding of the production, exchange, contestation and use of spatial knowledge by actors and networks *within each of these domains in each city and across the cities*, including the discourses and knowledge products and the outcomes in the domain produced by the specific spatial knowledge configuration. Since the SKMC is a set of specific connections related to spatial knowledge management in each city, within its historical and geographical context, the comparative approach allows the connections across cities to be compared within each domain.

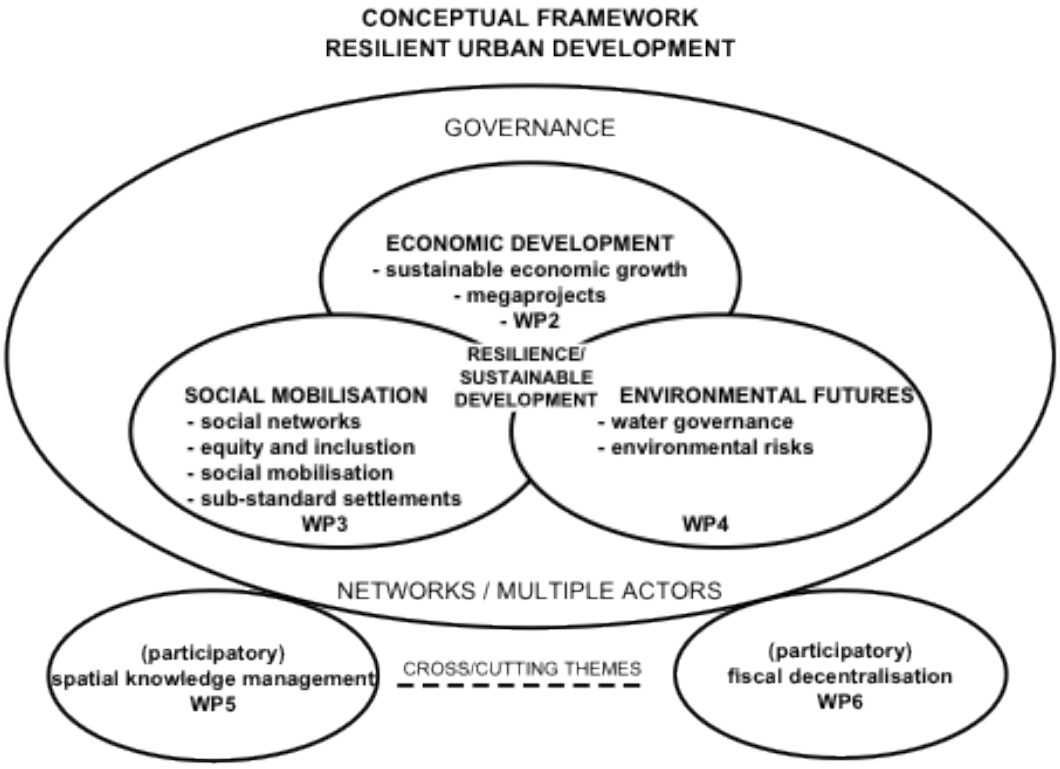
3.4. Choice of Domains

At the outset of the project, the domains of economic development; social mobilisation; environmental governance were selected as the key domains that intersect through a governance process (a set of actors and networks) to produce sustainable development. (Figure 3.1)

The conceptual framework for the C2S project proposed that there were two cross-cutting themes which were both participatory SKM and fiscal decentralisation (Figure 3.1). These five themes or domains were then proposed as separate 'work packages'(WP2 – WP6) which would development their own theoretical framework and methodologies to answer their internal research questions; as well as applying the conceptual framework of SKM developed by WP5 to answer questions related to spatial knowledge management within their specific domains. The reason for the latter application of the SKM research questions within each domain arises because the *main overall research question* posed at the outset of the research, is: how can spatial knowledge management (SKM) and participatory governance contribute to resilient/ sustainable urban development? A paper on the analytical framework developed to answer this overall question was developed in the final year of the project in order that the main questions of the C2S project could be answered (Peyroux, et al, 2014).

This thematic report on SKM presents the development of the concept of the *spatial knowledge management configuration* as the theoretical tool that would show the role of SKM, how SKM is embedded within strategic urban domains, compared across cities, in contributing towards the understanding of how cities of the South are transitioning to more sustainable futures. We suggest that this concept provides a lynchpin for the comparative analysis across the cities studied of the role of SKM and in so doing, will make

Figure 3.1: Initial conceptual framework for sustainable/resilient urban development



a contribution to current debates about the way in which cities are transitioning to become more sustainable in the face of climate change and economic austerity.

3.5. Qualitative Methodology

Qualitative Approach

This section provides a broad overview of the generic methods used in SKM configurations. The research held a workshop in Sao Paulo, Brazil in October 2011, to debate the methods to be used and finalized them with the whole research team in the course of that academic year. Since the C2S project has adopted the more contemporary comparative approach to compare SKM across cities, a qualitative methodology was adopted to be used in the field work as this the most appropriate methodology for providing data in order to compare networks, discourses and processes across cities. It is also appropriate because most of the research team are social scientists with a broad understanding of qualitative research methods. While it is recognised that there are many different ways to collect and interpret data within the various social science disciplines, *interviewing* research subjects is one of the most common methods for eliciting qualitative data and was used as the main data collection tool for C2S. There are also many ways of interpreting qualitative data, but it is stated that the main interpretive methodology adopted is that of *'thematic interpretation'*[18]. However, while this is the dominant approach, within the domains and related student theses (some fifity), small-scale quantitative surveys have been undertaken providing descriptive statistics to contribute to answering the research questions.

Sayer (1984: 222) provides a very useful definition of qualitative fieldwork as having an 'intensive research design', while quantitative research has what he terms 'extensive research design'. Extensive research is essentially positivist, seeking generalizations, while intensive research is aimed at interpreting the meanings people generate in specific situations. Intensive research commonly makes use of the researcher interviewing respondents to obtain qualitative and narrative information aimed at teasing out the 'deeper well springs of meaning' underlying people's experiences, and understandings – the ways in which people make sense of the everyday lives; thus qualitative researchers attempt to make sense of, or interpret, social reality in terms of the meanings people ascribe to it (Mottier, 2005). It is within this approach that the methodology of the C2S research project is located.

Within this approach, the subjectivity of the researcher and the research subjects is valued and researchers assume that they are part of the social world they are studying (Mottier, 2005). Research is seen as a reflexive process with researchers and subjects co-constructing meaning. Researchers in the C2S project have therefore reflected on their positionality in order to understand their role and influence in knowledge production (Rose, 1997; Visser, 2001). Working collaboratively has resulted in the research team going through an intense social learning process and has led to lively debates, which have enriched the outputs of the research.

Interpretative, qualitative research needs to take into account the cultural and historical situatedness of socially constructed meanings by social actors, and the interpretations that researchers develop of them (Mottier, 2005). The historical situatedness of the comparative research of the Chance2Sustain programme is that all case studies are in rapidly growing cities in developing countries in the early 21st century, and that research subjects dealing with inequalities included the structural group of poor people living in sub-standard housing, facing unequal distribution of basic services, and other actors involved in knowledge construction and policy making to deal with the social and economic inequalities and environmental threats facing cities in the developing world. (For each city there is a 'Country Report' and a 'City Report' describing the social, political, economic and environmental context of each city – see C2S website.)

It is important to note that 'interpretive' research produced qualitative interpretations of the sets of connections and attached processes captured within the SKM configuration for each city; as well as interpretations of qualitative data relevant to their domain questions.

Data Sources

Primary data sources are predominantly the oral evidence collected (co-produced) through interviews with the relevant actors within each domain, which was then translated and transcribed into texts, as well as those undertaken with key government actors involved in housing and service delivery; representatives from NGOs and CSOs; and the business community and related consultants. Primary documents also provided a source of data. These texts, such as minutes of meetings, policy statements, audits, newspaper articles etc., have also proved to be a useful data source, particularly municipality documents.

18 These guidelines have relied substantially on Kitchen and Tate's text on *Research Methods in Human Geography* which provides a relatively conventional set of methods applicable across the social sciences.

Participant observation, e.g. attending meetings, rallies, protests, has in some domains provided important sources of information, especially in the case of the scenario workshops held in WP4.

Access to Study Area

It was necessary in most cases to seek permission to access actors in particular municipal departments and this was negotiated in the case of each city. In some cities, permission had to be gained from a variety of 'gatekeepers' to work in particular communities, e.g. the councillors in the South African context. There were cases where some actors were not accessible.

Ethics

A proposal was submitted to the researcher's institutions as part of an application for ethics approval through the relevant Ethics Committee in order to obtain ethical clearance; all research subjects, in any of the interview processes, were assured of anonymity; and were required to sign an 'informed consent form' or to verbally give permission that the data produced in the interviews can be used for research purposes

Data Collection and sampling

Individual and key stakeholder interviews: Semi-structured, open-ended interview schedules were used to conduct individual and key stakeholder interviews. This format allowed for a relatively informal interview process to tease out the meanings that actors hold with regard to spatial knowledge management, the networks that they are part of and the value of these, the discourses employed; the SK products they produce, use and exchange, and their experiences they have had in contesting knowledge and their awareness of the outcomes of the knowledge. Actors here included: councillors, politicians, municipal officials, NGO and CBO representatives, consultants and community members.

Sampling: Purposive and snowball sampling was used to select relevant actors in relation to SKM and this differed in each context. However, in the main, relatively small samples of actors were selected which is typical of a qualitative intensive research design, where an 'illustrative' rather than a 'representative' sample was required (Valentine 2001, 46). Sayer, (1984) suggests that the research subjects, being part of the same 'causal group' (structurally defined group) will provide accounts of their meanings and experiences within their causal context. The local knowledge of members of the research team living and working in the case study cities contributed to an informed sampling process.

Training of research assistants and students

Research assistants and translators were trained in both the *content* of the research project (themes, research questions) as well as the *skills* required in the process. In the case of students, local supervisors often accompanied them to the interviews, and the information they collected fed into the broader C2S data pool in each domain.

Overt participant observation: The participant observation that occurred was overt, which means that the researcher/research assistant joined the group being studied in order to share their experiences and informed the group that he/she was observing them (Kitchen and Tate, 2000). The main form of participant observation was the attendance of public and committee meetings related to the context of the research. As part of the project, in order to disseminate the knowledge collected and interpreted by the team, a variety of forums in the cities were used to present the results of the research, e.g. the FORA meetings in Lima, Peru, (a broad range of actors including politicians, officials, NGOs, political parties and civil society organisations) and the MILE seminars in Durban (presentations to councillors and officials)

Interpretation

Interpretation of qualitative data "lacks the formal rigour of standardized procedures" associated with the analysis of quantitative data (Kitchen and Tate, 2000, 229). Interpretation is proposed to be an inductive process which is relatively open-end. The most common form of interpretation is what might be called a 'thematic approach' to interpretation. Thematic interpretation can also be used to interpret observation notes or primary documentary material, e.g. letters and minutes. The following stages were undertaken in thematic interpretation of qualitative information in the SKM theme:

Description: The situational and contextual information about the social processes being studied was described which included the places and social, temporal and situational context in which the interviews took place, as well as any events or factors that could have influenced the nature of the data being collected. Any factors that might have influenced the interviewing process proceeded throughout the data collection process were noted. As

interviewing in a community is an "on-going process of social relations" (Kitchen and Tate, 2000, 234), an understanding of the stability of the social context during the data collection process needs to be understood. This stage also includes the translation and transcription of the interviews in preparation for interpretation.

Classification: In the next step of the thematic interpretation approach the data were *classified* and *coded* and a set of themes (categories), derived (Kitchen and Tate, 2000). Themes were derived from both the empirical evidence and in relation to theoretical concepts from the literature review. With interrogation of the themes sub-categories were identified. The set of themes and sub-themes constituted the structure of the data. In some cases the themes identified were in the form of 'discourses' espoused by specific actors or coalitions of actors.

Linking and connecting: The final step in the thematic interpretive approach requires the patterns that have emerged from the categorization of the data to be analysed and an *explanation* or *interpretation* provided for the trends or patterns of meaning in the data (Kitchen and Tate, 2000). This was undertaken by the lead researchers in each domain.

Corroboration: A range of data sources were used to 'triangulate' the data as possible to provide legitimate knowledge as the output of the research process. Corroboration allows for the strengthening of knowledge claims (Kitchen and Tate, 2000).

Challenges

There were many challenges in undertaking the WP5 data collection, sampling and interpretation; the situatedness of researchers in different contexts and the challenge to remain culturally sensitive in each specific context, particularly the researchers from the developed world working in urban contexts in the south; the difficulty of negotiating unequal power relations in various contexts; language barriers and the need to work with translators who had their own positionality and schema for making sense of respondents feeling and views; the need to train translators, students and research assistants; and the experiences with gatekeepers in the process of purposive sampling.

3.6. Research Team

In each city, there were researchers from both the North (Netherlands, France and Norway) and South (India, Brazil, South Africa and Peru) working together in the five domains of: megaprojects; social mobilisation and social exclusion; water governance; spatial knowledge management; and city budgeting. This research project is unusual in that the researchers from North and South worked collaboratively throughout the project, both contributing iteratively to the development of theory appropriate for understanding urban development in cities of the South, so that comparison of urban processes across the cities could take place. Furthermore, the intimate knowledge of the case study cities held by the researchers from the South who live and work there provided a rich source of local knowledge to inform the interpretive analysis.

The overall frame for the Chance2Sustain paper emerged as a product of inductive and deductive thinking. The empirical results of the research revealed the importance of governance in sustainable urban development, while at the same time, our in-depth literature reviews and internal discussions of the literature related to resilience and sustainability, assemblages, governance and sustainability transitions contributed to the notion of the 'spatial knowledge management configuration' which emerged as what we consider as the important concept for understanding SKM comparatively. Thus, the theoretical insights and the empirical evidence were iteratively combined through collaborative debate and application among the research team to produce the analytical framework of SKM configurations for urban transformation (Final Analytical Framework, Peyroux et al. 2014). For us what is interesting and important is the conceptual structure of the final analytical framework, as well as the process through which it was developed.

3.7. Involvement of Students

Over a period of four years some fifty students worked in the case study cities on topics related to the C2S project. The students from the University of Amsterdam (UoA) were co-supervised by a local supervisor from the South and an academic from the UoA who was involved in the project. In addition, students registered at Universities in the case study cities in the South also undertook their Master theses with local supervision. The knowledge produced by these students contributed a great deal to the project and enriched the pool of data. Five PhD students were linked to the research project and they researched/ are still busy with their research in the cities of Cape Town, Delhi, Kalyan Dombivli, Chennai, and Lima. (A list of students and the titles of their theses in available on the Chance2Sustain website.

4 Emerging Issues in Spatial Knowledge Management Configurations: e-Governance in India, Brazil, South Africa, and Peru

In this section, we discuss the results of the case studies carried out in seven cities of the research project, examining the emerging issues in spatial knowledge management configurations in the four countries concerned[19].

4.1. Discourses and rationales for introduction ICT-GIS-based spatial knowledge management systems

In the 1990s, "developments such as faster and cheaper computers, network processing, electronic data publishing, and new data capture techniques such as GPS spurred rapid growth at Esri", the main company producing spatial data analysis software. Esri's first desktop GIS, ArcView, opened up the possibilities of GIS to a whole new group of users. During the late 1990s, Esri reengineered ARC/INFO to develop ArcGIS as 'a modular and scalable GIS platform' that would work both on the desktop and across institutions. Once GIS was commercially available in this form, government departments and municipalities across the globe began to introduce GIS.

The research shows that in our case study cities several discourses were used as rationales for introducing ICT-GIS-based spatial knowledge management at the local governance level, usually linked to how local governments work in their specific institutional contexts. These discourses relate to four issues:

Strategic urban planning and integrated land use planning;

a. Determining geographic boundaries as a pre-condition for planning effectively and changing boundaries as part of an urban development discourse;
b. Streamlining work processes of local governments and their relations with other levels of government, citizens and the private sector,
c. Poverty and needs assessment mapping and location of facilities.
d. The case studies show the discourses used as rationale for introducing ICT-GIS systems (Figure 4.1).

19 Callao was included as case study because of its far advanced digitized GIS network set up by the regional government with local governments in the region. It provides an example of possible future developments in other cities and regions in Peru.

Figure 4.1: Characteristics of case study cities

	Strategic urban planning/ integrated land use planning	Determining geographic boundaries	Streamlining work processes local government	Poverty, needs assessment and location of facilities
Delhi	x	x	x	x
Kalyan Dombivili			x	x
Chennai		x	x	x
Lima		x	x	x
Callao	x	x		
Durban (eThekwini)	x	x	x	x
Cape Town	x	x	x	x
Guarulhos	x		x	x

Strategic urban planning and integrated land use planning

A first rationale for using ICT-GIS-based KM concerns strategic urban planning and integrated land use planning. This was found mainly in South Africa and Peru (to some extent in Brazil), in contrast to India where this discourse was largely lacking (Table 4.1)[20].

In South Africa, after the 1994 change of government, a transformative vision of reducing existing spatial segregation and inequalities linked to apartheid policies was developed. Now, urban strategic planning by local and provincial governments includes a strong spatial perspective, in which the Spatial Development Framework plays an important role in guiding future urban development (Watson 2002). In Durban and Cape Town, strategic urban planning centres around the notion of the 'compact city', where high population density facilitates building facilities and providing services, and a spatially defined 'urban development line', outside of which only alternative facilities or less sophisticated facilities are provided. In Cape Town, the notion of the coastal edge has been added to the most recent spatial development framework (SDF, 2012), delimiting spatially areas of the coastal zone with environmental risks, structuring future development processes there.

Strategic planning in post-apartheid South African cities continues to be dominated by a spatial discourse of nodes, corridors and urban edges, although shifting in the 1990s to include the neoliberal discourse of competitive, managed cities through the Growth, Employment and Redistribution (GEAR) policy, in which market influence in determining the spatial form began to emerge. Examples are the "private-sector-driven, up-market, commercial and residential" gated developments such as Gateway in Durban and Century City in Cape Town. Lured by the promise of large rates income, many municipalities allowed these developments to proceed even when not conforming to local development plans (Harrison et al, 2009: 139).

A second discourse found in spatial KM concerns integrated land use planning processes in which geo-referenced databases from different sources provide evidence for policy choices (found in Cape Town, Durban, Callao, Lima, Guarulhos, and Chennai- see Table 4.1). In each case, different actors and processes are involved.

In Durban and Cape Town, urban spatial planning was revolutionized in the 1990s by linking digital databases and maps, providing fairly up-to-date maps on spatial spread of urban phenomena, to decision-making.

In Peru, the regional government of Callao works on integrating land use planning together with several municipalities bordering Lima city and including parts of the metropolitan region of Lima[21]. The regional government is a leader since 2009 in developing ICT-GIS-based KM systems for local governments in that area, integrating planning for the region, based on three knowledge processes; spatial planning, determining boundaries, and producing specific reports for the regional planning network. For spatial planning, knowledge documents are prepared collectively by the Callao regional government, working with the line departments of its government, local governments, NGOs and knowledge institutes (MIP) in a *concertación* process[22]. Delineating boundaries in a common database was a precondition making planning feasible, reducing legal contestation. Specific reports on strategic topics complement the extensive data collection and mapping as basis for decision-making; publicly accessible through an open-access website[23].

In Guarulhos, Brazil, integrated land use planning has been a major concern in the municipality for over a decade. Collecting, organizing, and analyzing (spatial) data to inform urban development policy has been a key process, in attracting major municipal investments to peri-urban and poorly serviced areas for greater social inclusion. Although Guarulhos is the second largest municipality in the state in terms of economic activity and population, it is a small player in the SP metropolitan region[24]. In Guarulhos, the overall Development Plan developed in 2004 defined five geographic zones defining the broader terms for municipal development, environmental protection and social responsibility. A new development plan is being drawn up,

20 In Chennai the Development Authority has their own GIS section, which provides maps for the Master Plan.

21 This area is strategic in terms of economic activities (harbour, airport, industry), as well as environmentally important (coastal zone), with higher levels of immigration than elsewhere.

22 They include the report on delineating and determining territorial boundaries in Constitutional province of Callao, zoning for spatial demarcation and organization of district of Ventanilla, reports on human settlements (Mercedes Mi Peru, Porcino Park project, a report on all settlements in Callao, and one on hazards in human settlements in Callao province).

23 In Lima, an environmentally determined isoline exists below which water provision is much easier than above, due to the location of the water pumping station.

24 This is the result of the size of the city of Sao Paulo itself, as well as of institutional challenges to orchestrate action plans by a metropolitan body.

which translates the existing broad guidelines into more concrete issues, and is strongly influenced by improved data production (integrating data bases) and administrative modernization. This has meant that discussions between government departments and with professional associations and private sector interests in the city are based on reliable data (trends). The final goal is to integrate various databases through a Web Geoportal, linking map polygons to administrative procedures as well, making the zoning plan a true instrument in implementing and enforcing urban planning.

Determining municipal boundaries

A second discourse coming out of the case studies concerns the ways in which boundaries for urban development strategies are established when KM is digitized and spatialized. First, boundaries (of individual plots or city boundaries) have to be established more accurately when linking databases to base maps in GIS for city planning decisions. Delineation of informal settlements is increasingly being used for monitoring and strategic development purposes.

In South Africa, establishing physical boundaries is a much-contested process and by law has to be accompanied by lengthy and detailed public participation processes. In Durban redrawing municipal administrative boundaries was part of the post-1994 spatial restructuring creating wall-to-wall municipalities, bringing marginal areas into larger municipal entities to reduce spatial segregation effects. Durban became eThekwini Municipality, and Cape Town the City of Cape Town. The main idea was that changed municipal boundaries would produce cross-subsidization, and smooth inequalities. Thus, boundary demarcation can be explicitly part of a political transformative process. Once finalized, the boundaries were integrated into databases and base maps for planning urban development. The Census 2002 results joined to geo-referenced municipal base maps allowed systematic mapping of existing urban inequalities. The boundary drawing process was effective because of the sophisticated GIS mapping system used.

In Peru, the precise demarcation of boundaries between municipalities within the constitutional province of Callao undertaken in preparation for the ICT-GIS system was a pre-condition for current spatial planning processes, which can now go forward in that area, directed towards ecological economic micro-zoning and the spatial management plan.

In Guarulhos, Brazil, and Kalyan Dombivili, India, determining municipal boundaries are less driven by technical GIS requirements. However, unresolved boundary issues do exist.. Due to rectification of the Tiete river official boundary, the boundary between the municipalities of Sao Paulo and Guarulhos has shifted, changing total municipal area and creating hazardous areas for development due to flooding and lack of appropriate access. This is more a political and policy-related issue than a technical one that use of GIS or spatial information could help to solve. In KD, boundaries were also changed over time due to political preferences (see KD City Report).

City boundaries are also redrawn in the long run by city development plans and the economic expansion occurring through or despite city development plans. City development plans exist in all case studies; in KD the CDP of 2011; in Chennai the 2009 CDP Review; in Guarulhos the Macro-zoning plan of 2004; in Durban the Spatial development Frameworks in 2002, 2008 and 2011; in Cape Town the SDF of 2012. In India, Chennai, where the 'IT corridor' to the south of the city has dominated economic growth in the urban area (although economic growth there has also been fuelled by private developers building large-scale residential sites), the city borders were extended in 2011 by the state government to include large parts of the southern corridor in the new fifteen zones of the city. This implies that the revenues accruing from the included areas now go to the city government rather than to the districts.

In Callao, the provincial government is working with the municipalities in the region to develop background reports to be used for further detailed planning processes, linked to major issues in the area. These include hazards, disaster risk management, and studies of particular localities.

What this discussion shows is that digitizing spatial knowledge on municipal and plot boundaries requires much more accurate, up-to-date and non-contested information to support urban planning and development. Whereas SA had the instruments in place at a sophisticated level, these had to be developed in Peru by initiatives at the provincial level, and in Brazil and India are still in the process of being developed at local levels[25].

Work processes in local government: Administrative efficiency and effectiveness

A third discourse on introducing digitized and spatial knowledge concerns the expected improvements in efficiency and effectiveness, found mainly in India and

25 In India especially establishing land boundaries is an ongoing process with high levels of contestation (Collabland, p.c. NIT-Chennai 2013).

Guarulhos, Brazil. This discourse is very strong in India, where urban planning at the metropolitan level has been geared towards physical expansion of city areas through Development Authorities; allocating areas for economic and residential purposes, and building infrastructure for basic services and transportation[26]. The focus of e-governance initiatives in India has been designed to improve work processes in order to enhance "access and delivery of government services to benefit citizens, employees and management of urban local bodies" while aiming to "help strengthen government's drive toward effective governance and increase transparency..." (JNNURM, Mandatory primer 1, e-Governance, ULB reform, n.d.; p.2). The lack of accurate and up-to-date databases, among other issues, has hampered urban local governments in India from efficient and effective revenue collection and from being able to monitor developments in their cities; it has prevented residents from exercising citizenship rights effectively; and has allowed informal (corrupt) practices to become extensive (Roy 2009).

Initiatives for digitization and spatializing information within local government have been very uneven in Indian cities. However, our case study cities Kalyan Dombivili and Chennai have been early innovators in this respect.

Poverty and needs assessment mapping and locating facilities

Cities have also used digitized and spatialized knowledge for mapping poverty and deprivations to rationalize budget allocations to urban areas with the most pressing needs, a rationale found in both Durban and Cape Town in South Africa. The Infrastructure Branch of eThekwini municipality has developed a composite deprivation index to analyze the spatial concentration of deprivations derived from unemployment; income; GDP; infrastructure backlogs; and social facility backlogs, and developed two GIS models as tools for strategic decision-making: the 'Access to Services' model and the Cost Surface model[27].

Both tools provide the basic spatial information for decision-making on locating infrastructure. In contrast to earlier situations, the models both reduce unit costs promoting a compact city, and determining facility prioritization for informal settlements without services, and reduce political pressure on location choices. This model is now used in both cities in decision-making, and in Cape Town a more integrated decision-making process across the line functions of the municipality has also been promoted.

In India, RAY, the new national programme for urban poverty reduction and slum eradication, incorporates GIS-based slum mapping in its procedures. The plans are supposed to be participative and involve residents and NGOs/CBOs to guide community mobilization activities for Slum Surveys, data validation, and slum-level redevelopment/ upgrading models as part of Slum-Free City Plans. In practice slum mapping is only done in pilot projects currently. In both KD and Chennai consultant firms do this, not NGOs. In Chennai, slums in five zones have been surveyed, but with resistance by the residents, who have little faith in such processes (Sekhar, *Hindu*, December 15, 2012).

Actors and their networks

This section discusses the main actor networks that are building digital and spatial knowledge management configurations. In our case study cities the main actors are government departments at different scale levels, working individually or with hybrid networks (see Table 4.2). They mainly work closely with private sector companies. Cooperation with universities as knowledge institutions exists, but is less institutionalized. Urban residents are only recognized as producing knowledge in participatory consultation processes, and when producing data in feedback processes to local governments.

In Peru, the Callao regional government (Constitutional province) has established a strong network in the region with local municipalities, private sector, and NGOs. Callao works with other actors in exchanging knowledge through online information systems about regional and local issues (*concertación* process), and the network also produces

26 As urban development is a state subject, the central government through the JNNURM programme (2005-2010, first phase) has only recently provided a strong impetus for urban development authorities and local governments to integrate the many specific projects such as housing, transport, and water, into City Development Plans. These plans link projects and their financing with consultation processes, based on the financial standing of urban local governments and the extent to which their public administration procedures are efficient and effective. One condition of the JNNURM programme has been the introduction of ICT-based administrative processes and the use of e-governance (JNNURM, Mandatory primer -1, e-Governance, ULB reform (n.d.).

27 The 'Access to Services' Model models the supply and demand for social facilities across the Metropolitan area and is able to predict the future social services requirements for housing. The 'Cost Surface' Model predicts the cost of servicing any piece of land in the city.

Figure 4.2: Actors and their networks in urban ICT initiatives

Local government	Other government levels	Private sector	Universities	Citizens (NGOs)
Callao	x (regional)	x		x
Guarulhos	x	x	x, mainly in environment	not integrated with municipal databases
Durban (eThekwini)	x	x	x (MOU)	x
Cape Town	x	x	x (African Centre for Cities)	x
Kalyan Dombivili	x	x	x (technical advice)	x (e-grievances)
Chennai	x	x	x (technical university)	
Lima	x	x	x	
Delhi	x	x		

new knowledge by preparing *catalogues* on specific regional issues.

In Guarulhos, Brazil, local government is working on spatializing and digitizing information, and has informal social networks with a university on environmental issues. National initiatives provide the backdrop for establishing ICT-GIS-based systems (through the national spatial data infrastructure / Infraestrutura Nacional de Dados Espaciais (INDE)), and the national bureau of statistics (IBGE) provides socio-economic data as well as map layers to produce maps in a GIS environment for local government.

In South Africa, the City of Cape Town has widened its network by working with the African Centre for Cities (ACC) at the University of Cape Town. A series of 'city labs' provide sites of engagement between academics and city officials. Durban Municipality has recently started working with University of Kwazulu Natal (UKZN) and has signed a MoU for academics to undertake applied research with municipal officials on projects benefiting the city. The municipalities remain the primary actors within the networks.

In India, Kalyan Dombivili was an early innovator in promoting e-governance (1999) and is now a model for other local governments in Maharashtra. Although local government is the initiator, the private sector companies with which they work are very influential in determining the level of expertise obtained by local government. Initially experts with academic backgrounds were in the advisory committee, but this has been discontinued.

In Tamil Nadu, the local government in Chennai initiated a full-scale digitization project for itself, working with a private sector company in the late nineties. However, this was scaled down after several years. Other recent initiatives to link local government, development authorities and departments of state government in one network to develop integrated ICT-GIS system, have not yet been successful.

Knowledge bases

The types of quantitative information included in these digitized databases usually consist of expert, codified information produced through surveys (census, sample surveys), remote sensing images or land surveys, hydrological measurements, etc. For databases linked to administrative processes, the information included has to be classified into categories implicitly containing assumptions about strategic criteria, standards and cut-off points (e.g. levels of poverty linked to income, or existence of basic facilities). Databases which contain resident feedback on local situations, such as grievance data, need to be analyzed with due care, as they may represent those groups with good access to internet and mobile phones more heavily than groups with no or less access (cf. van Teeffelen and Baud, 2011; Martinez, Pfeffer and van Dijk 2011).

In terms of participatory KM, only a few cases were found. In Durban, lay people's science was found to be part of the knowledge base only in South Durban and is linked to the issue of air pollution (see section on contestation). Community-based knowledge has been included more explicitly in the Callao case, where NGOs are included in the *concertacion* process, producing

Figure 4.3: Line departments where ICT-GIS is incorporated in case study cities

Local government	**Durban**	**Cape Town**	**Guarulhos**	Callao	Kalyan-Dombivili	Lima	Chennai	**Delhi**
Strategic Planning	x	x	x	x			x	x
Property tax assessment and collection	x	x	x		x (only ICT-based)	x	x	x
Housing	x	x	CAD system				x	x
Service delivery (admin.)	x	x	x					
Water billing	x (water bill sent out with property tax bill)	x (water bill sent out with property tax bill)	?		x			
Feedback from citizens to local government (grievance systems)	x	?	Citizen-portal; internet; administrative	x	x (only ICT-based)			
Vulnerability Issues (Disaster and Risk management)	????	x	x			x	x	x

Note to the table:

- *Strategic planning*: Durban (located in office of city manager with subsidiary systems in each department), Cape Town (central unit plus departmental specialized units), Callao, Chennai has Master Plan by CMDA, and Delhi has Local Area Plans.
- *Property tax*: Guarulhos, Kalyan Dombivili, Durban, Cape Town (South Africa has a well regulated, accurate cadastral information system to define property ownership rights which forms the basis for land valuation; land taxation, development planning, local authority demarcation and land administration for all public and private property in cities and rural areas – other than communal land). This is not the case in India where property ownership is a complex issue with many types of urban land in different areas of the city, although in Chennai it is used where possible with private sector and middle class developments and in Delhi there is a recent project for Geospatial property data.
- *Housing*: Durban and Cape Town use the cost surface model to locate and prioritize housing developments. India has just instituted the RAY programme, in which slums are supposed to be 'mapped' using GIS systems. This is not yet implemented in practice, except through pilot surveys. In Delhi slum mapping is extensive, though its purpose is not yet clear. In Lima it is linked to the upgrading of informal settlements.
- *Service delivery:* Durban and Cape Town use GIS spatial models to locate and prioritize areas needing services.
- *Water billing*: In Kalyan-Dombivili., the water billing department uses digitized databases, but their reliability and validity is heavily contested. Water billing linked to property tax billing in SA.
- *Vulnerability issues (Disaster and risk management)*: Chennai has undertaken highly technical aerial mapping to create digital elevation model for flood management, in Delhi SDI is at state level. In Lima housing projects are including risk mapping initiatives, however in general it is not integrated. Cape Town has their Coastal Protection Zone to identify risk space.

databases on specific regional and local topics. In Guarulhos, Durban and Chennai, community-based NGOs provided their own databases with spatial dimensions through websites, engaging with neighborhood residents and local government and private sector companies (cf. Pfeffer et al, 2012).

Spatializing databases (i.e. matching databases to base maps) is gradually taking place. In Durban and Cape Town, after the boundaries of the municipalities were finalized in 2002, the census was linked to the geo-referenced base maps of each city. In KD, India, the local initiative has run up against technical and organizational difficulties in matching both within local government, because two private sector companies are involved in a conflict. An additional issue more generally in India is the security surrounding planning maps, which means that they are not available outside the line department for the general public. Coastal maps also come under national defence rules, which means they are not available publicly. This has negative implications for disaster risk assessment (floods, tsunamis).

4.2. Knowledge exchange and contestation

A basic rationale for digitizing and spatializing knowledge is the possibility to exchange and coordinate it for more effective local governance. However, questions of equal access and contestation of knowledge need to be included in such discussions.

The first issue concerns the (*lack of) knowledge sharing* among municipal departments, which limits the possibilities of integrating mapping of issues for strategic forms of urban planning (e.g. such as used in Callao or Durban). In Durban, data files are on a central server and shared by line departments; each department can build on this central database with data relevant to their function. In Callao a similar infrastructure works at the regional level, to provide information across municipalities and local and regional government. In Guarulhos, a joint municipal geo-portal is being developed for limited data exchange between departments. In India, the majority of projects are cocooned within their own organization, and sometimes even within the GIS department. In Kalyan Dombivili the lack of information shared within the municipality between departments (despite the technical means to do so) means that the opportunity of streamlining or integrating information on social policy, on environmental issues and on revenue collection is lost.

The second issue concerns relations with the private sector. *Exchanges can be limited and contested* in the relation with the private sector working as consultants to local government. In Kalyan Dombivili, private consultants can analyze the data, a capacity lacking among municipal staff. In Durban, influential GIS consultants are commissioned to analyze spatial data. They provide for the ability to use knowledge to more advantage.

A third issue concerns the extent to which staff in various organizations can undermine the *potential transparency* of such systems. This applies particularly in situations in which KM systems include monitoring systems of payments by citizens or others, and staff input records of such payments. Existing systems of kickbacks, reduction of payments, and other forms of corruption are threatened by ICT-GIS, and therefore their introduction or correct use is resisted. Audits of e-governance in KD and Chennai have signalled such issues.

A fourth issue concerns the limited input of community knowledge. In Durban and Kalyan Dombivili, councilors provide local-level knowledge directly to local government, whereas (middle-class) residents mainly provide feedback through grievance systems (Martinez et al 2011). In Durban, input from poorer communities is limited due to procedures followed in public participation processes, which exclude those without access to public media. Knowledge from the communities is fed into municipal processes by councilors, and vice versa. When such Ward Committees became 'dysfunctional', the system became vulnerable. Currently, the Durban Ward Committee system is being re-generated, which will increase the democratic nature of the public participation process as all communities are represented. In contrast, in defining the 'urban edge' for Cape Town's Spatial Development Framework, there was an intense process of negotiation with the business sector to reach agreement on the development line. Direct input of community information, such as property tax information and grievances, shows a bias in favor of middle-income groups with a readiness to contact municipal officers directly.

In grievance systems, residents' knowledge is incorporated in specific ways. In Kalyan Dombivili and Chennai, internet connections are not pervasive enough for it to serve as general platform for feedback, and mobile phones are used as platform.

A fifth issue is whether GIS provides 'objective knowledge' for decision-making (i.e. valid and reliable knowledge). In Durban, the Infrastructure Unit promotes GIS as an 'objective' form of knowledge allowing facilities locating and prioritizing service provision free from political

influencing. However, assumptions about the validity of such databases need to be checked in practice. This concerns the validity of indicators used to reflect the issues concerned, the reliability and accuracy of the data input, and the regular maintenance of such data inputs, so that they reflect actual situations. In India, eligibility for food subsidies is determined by households' 'below poverty line (bpl)' status, which is both determined by political access as well as income levels. Therefore, databases on bpl households reflect a set of mixed criteria, making such databases invalid for poverty mapping.

4.3. Implications for the future: using (participatory) spatial knowledge management (SKM) for urban development

In this last section we come back to the main question raised in our paper concerning how knowledge management (KM) within urban governance is being transformed by digitization and spatialization through the use of ICT and geographic information systems (GIS) and its effects. KM systems consist of several dimensions: 1) the discourses around digitized KM and types of information/knowledge acknowledged/denied; 2) the networks of actors producing socio-spatial knowledge; 3) embedding of KM in decision-making processes; and 4) the effects of KM on work practices and outcomes.

ICT-GIS based knowledge management were multiple and varied by city, organizations and their mandates. The discourses concerned four issues: strategic urban planning and integrated land use planning; determining geographic boundaries in urban development; streamlining work processes of local governments, and mapping poverty and needs assessments. This suggests that in the South, the main rationale of using digitized and spatialized knowledge is focused on gaining a firmer control of complex urban development processes, by establishing non-contestable boundaries, and expanding urban and land use planning databases. This focus is strategic for future economic growth, but also provides inputs for prioritizing improvements in basic services and reducing inequalities. Importantly, knowledge management was geared towards increasing government competences in tax collection, reducing corrupt work practices, and improving management information systems.

The actors producing knowledge recognized generally in urban planning and management mainly government working with the private sector. Initiatives come from national as well as local and regional initiatives. The strongest networks in developing ICT-GIS initiatives are found between local governments and the private sector. However, the greater technical expertise of the private sector means that their power over local government is strong and likely to grow as the 'smart city' discourse requires technical expertise outside local government competencies. Links with knowledge institutes and civil society organisations in developing knowledge management are weaker.

The main areas in which ICT-GIS based knowledge management was introduced, concern strategic planning, tax assessment and collection, and locating facilities. Some initiatives were also found for greater interaction with urban residents; increasing access to information on administrative processes through websites, but also through grievance feedback systems. However, these were used mainly by middle-class residents. Low-income residents still access the state through political representatives. Generally, low-income urban residents remained excluded from the ICT-GIS based knowledge management processes, both through lack of competencies as well as through lack of confidence in the effectiveness of such procedures to work effectively.

Generally, spatial knowledge platforms and mapping products are strongly dominated by experts, using and producing codified and technical information products. This information is positioned as objective, but is occasionally contested. Several examples were also found in the city case studies of civil society initiatives to build ICT-GIS-based knowledge platforms and databases (see Pfeffer et al. 2012; Albert in preparation). In addition, more deliberative processes in Lima are being studied (Miranda and Baud, forthcoming), which show that when 'spaces' are created for more interactive processes these can contribute to mutual knowledge building to some extent. Also the regular interaction in Durban between citizen initiatives and city experts leads to exchanges of information and mutual knowledge, specifically in the water and sanitation sector. Finally, field studies among local communities are eliciting how residents utilize community-based knowledge for building up livelihoods (Alberts, in preparation; theses by van Turenhout and Uitterhoeve).

Knowledge exchange remains a difficult issue. Even within government, knowledge does not travel well between departments and different scale levels of government. Knowledge sharing is scarce, and in some contexts there is an active resistance to digitizing internal databases for fear greater transparency and control will reveal incompetence and corruption. However, some initiatives are being undertaken in this area. Feedback from

residents is usually limited and confined within strict guidelines. However, counter-mapping issues elsewhere is opening up through NGOs (e.g. Cheqeado.com in Argentina, Ushahidi in Africa; Trasnparent Chennai in Chennai).

The main conclusion is that building ICT-GIS based knowledge management configurations is very uneven, across cities, sectors, and countries. Although a variety of rationales for doing so exist, related both to the discourses on urban growth, effective urban management and reducing inequalities, a great deal of effort is still needed to implement ICT-GIS spatiak knowledge management in such a way that they include a variety of knowledges – including from citizens–effectively into urban planning and management in many cities in emerging economies.

5 Varieties of Urban Spatial Knowledge Management Configurations; Comparing City Configurations and Their Links to Other Domains

In this chapter, we turn to the question of how cities have developed spatial knowledge management configurations, and how their national context affects the opportunities that cities have to utilize spatial knowledge management in their activities. The analysis is done at the level of the city spatial knowledge management configuration (SKMC), i.e. the actor coalitions and networks rather than individual organizational actors.

5.1. SKMC per city

5.1.1. Cape Town, South Africa

Introduction

Like all cities in South Africa, the municipality of Cape Town post 1994 was faced with the major challenge of spatially re-integrating the city to address racial inequalities and poverty created by apartheid. Before any substantial policy change could take place, administrative, political and spatial units had to be brought together. In terms of spatial amalgamation, a conglomeration of different municipal authorities and Black Local Authorities (also known as townships) had to be consolidated into one unified metropolitan authority. Starting out with 61 local, racially segregated entities with different functions and levels of political authority – "devoid of democratic legitimacy" – the transitional local government forum in Cape Town agreed to reduce this number to 39 (Jaglin, 2004:233). After the first municipal elections in 1996, a second phase of restructuring took place reducing this number to six municipalities under the authority of the Cape Metropolitan Council, the so-called '6+1 structure'.

The Integrated Development Plan (IDP) is the City of Cape Town's principal strategic five-year plan, informing planning, budgeting and development in the city, and hence all of its other strategies (City of Cape Town, 2013). The IDP is aligned with the outcomes and objectives of national government and the Western Cape provincial government, specifically the National Development Plan (2012) and the Future Cape 2040 process which has now evolved into *OneCape* 2040. Initially the Future Cape 2040 process was conceived to develop a 30 year vision and brand for the Western Cape Province (City of Cape Town, 2012b). This process was managed through the newly formed Economic Development Partnership (EDP)[28] appointed by the Western Cape government.

At the same time the City of Cape Town initiated its own long term City Development Strategy (CDS), called Cape Town 2040. Like the Future Cape 2040 project, the CDS was envisaged to encompass a long-term 30 year collective vision, goals and interventions for the city of Cape Town. These two processes have now been consolidated into one combined long-term strategy for the city and province,

28 The Economic Development Partnership (EDP) is an independent non-profit company accountable to its members to drive a partnership-building process in the Western Cape. It seeks to empower local and regional government, the private and non-profit sectors, and communities with the opportunity to work together to improve the local and regional (and hence, the national) economy. It focuses on enhancing competitiveness, increasing sustainable growth and ensuring that growth is inclusive' (Western Cape Economic Development Partnership, 2013a). The EDP currently has over 130 member organisations representing a wide spectrum of economic and development interests in the region.

renamed as OneCape 2040 (Western Cape Economic Development Partnership, 2013), and managed by the EDP for the Western Cape Government, and the City of Cape Town. Two important observations can be drawn from these developments: firstly, the close alignment between local and provincial government which would not have been possible politically a few years ago; secondly, the appointment of the EDP to undertake this process represents the growing power of external economic and development interests in public strategy formation, less likely in an ANC context.

GIS technology has been in use in South Africa since the late 1980s. However, it was only since the 1996 census that both the spatial and tabular data were distributed in digital form. The CT Municipality captured the orthophotographs digitally for Cape Town in the same year and thus the census could be mapped spatially. The Khayelitsha/ Mitchell's Plain 2000 Survey is an example of early research undertaken by academics using GIS in Cape Town. Since then, the CT Municipality has developed an extensive ICT-GIS system through which a range of different spatial and infrastructure plans are processed and housed. Its central Information Systems and Technology service is housed in Corporate Services, while separate GIS systems exist within a range of departments to cater for their specific data needs. The city's recent decision (City of Cape Town, 26/10/2012) to roll out broadband infrastructure throughout the metropolitan area will not only improve business communication in the city but will also facilitate high speed data communications to municipal facilities.

While the Municipality is responsible for updating, reviewing and making its plans accessible to government and the public, it relies heavily on consultants in preparing plans and related policies. Cape Town has a strong environmental lobby and environmental NGOs and consultants are active in using GIS as consultants or advisors to the Municipality. Western Cape provincial departments also have GIS capabilities, in particular the Department of Environmental Affairs and Development Planning. The University of Cape Town, through the African Centre for Cities (ACC) and other departments, is actively engaged with the Municipality and contributes information and data for municipal decision-making.

The next section presents an outline of the main discourses and uses of GIS; the actors involved; and four ICT-GIS products developed and employed by the City of Cape Town to guide development decision-making: the Cape Town Spatial Development Framework (SDF); the Urban Edge; the Coastal Edge; and the Cost Surface Model. The main focus is the SDF developed by the Spatial Planning and Urban Design Department and finalised in 2012, after an extensive formal process of public participation including stakeholders from government, business and civil society. The Urban Edge and Coastal Edge are key elements of the SDF, but are discussed individually to unpack how they were developed as defining spatial concepts dominating the city's spatial development landscape. Of interest is how environmental and coastal planning is integrated much more strongly into the SDF and the Cape Town's other spatial plans, compared with eThekwini Municipality.

Discourses and rationales for introducing ICT-GIS-based KM in urban governance

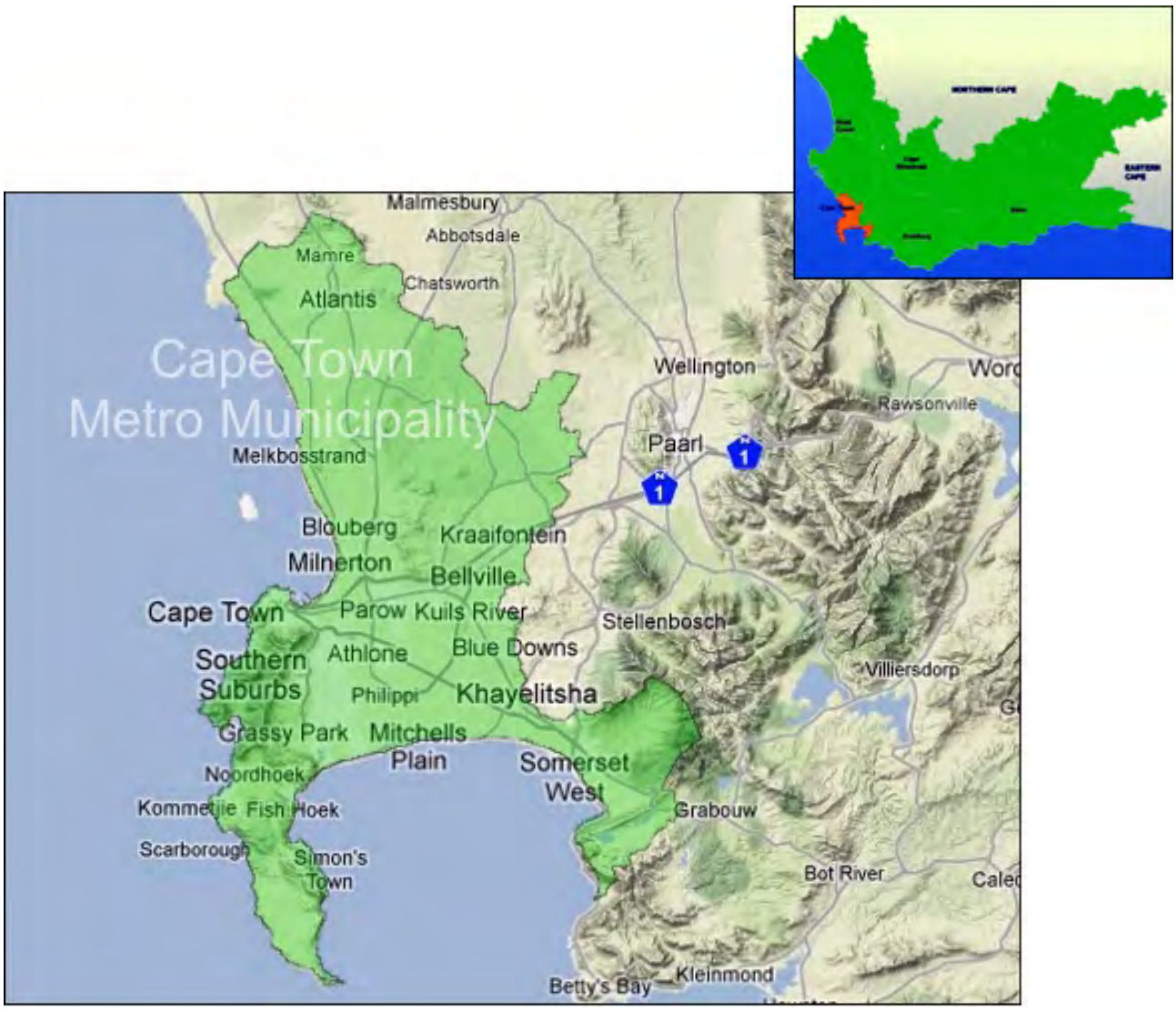
In 2001, when the new municipality boundaries were finalised by the Demarcation Board, seven neighbouring local authorities were amalgamated into the City of Cape Town. (See Fig 1) The intention of creating new municipalities using GIS was to integrate the former black and white spaces of South Africa and consolidate and streamline municipal services across the metropolitan areas. For the City of Cape Town, with a population of approximately 3.2 million, this was a massive task, as the new municipality had to integrate seven 'stand-alone information management systems'. Most of these were technologically out of date and held different sets of data in different forms. The goal of the new municipality was to create a uniform system across the metropolitan municipality through the adoption of a 'smart city' strategy, standardising both data and technology and in doing so be able to serve the residents of the city better. This new holistic system would also allow the different departments to better communicate with each other (Bauman, 2008).

Prior to this, ICT-GIS based knowledge management in Cape Town and the surrounding local authorities had been built up and institutionalised in their own separate GIS systems as a function of the global development of information technology since the late 1980s.

For policymakers, ICT-GIS is used to collect revenue, carry out strategic planning (visioning); maintain municipal boundaries; increase the effectiveness of the knowledge base for urban development decision-making; and the forward planning and delivery of infrastructure, housing, services (specifically water and sanitation), and facilities– the delivery of physical infrastructure being the most important ICT-GIS use.

With the creation of the new City of Cape Town boundaries in 2001, the new metropolitan municipality sought to streamline the billing systems of the municipality and so an 'Enterprise Resource Planning' (ERP) was designed for standardized revenue collection across the

Figure 1: Cape Town Metropolitan Municipality with inset showing location in the province of the Western Cape.



new city spaces. Thereafter, an enterprise GIS was implemented based on Esri's ArcGIS platform, including the property geodatabase, the Water Services geodatabase, and the Planning and Valuations geodatabase with standardised data capturing protocols.

The ICT-GIS system has therefore provided a foundational role in the excellent financial management of the city by providing an efficient tool for managing land parcels in the city and collecting rates, and in spatial allocation of budgets in the city to address the needs apparent at the ward level throughout the city. With the municipality's implementation of SAP technology for businesses purposes and with the integration of this technology and GIS, the City of Cape Town linked its business information and asset location data and attribute data (e.g. pipes, sewage treatment plants etc.). The municipality is now capable of: working out the maintenance costs of incidents such as burst pipes, leaks etc.; determine water consumption patterns; and calculate the life span of various assets; and consequently, be able to budget for infrastructure maintenance and redundancy. Apart from this role in asset management, the integration of the SAP and GIS technology is also used for customer relations management (Baumann, 2008).

With the production of the Spatial Development Frameworks and Plans of the post-apartheid city since 2002, the finalization of the post-apartheid municipal boundaries and the introduction of the Integrated Development Plan (IDP) (advocating the twin imperatives of facilitating pro-poor and pro-growth urban development), the importance of spatial discourse has declined as the dominant discourse of strategic planning processes, and the concept of integration has emerged more strongly, as promoted in the

Integrated Development Plan. However, the importance of spatial knowledge and spatial tools are increasing as a means of delivering on the mandates of the IDP in addressing pro-poor issues. Land use zoning is still an important tool to plan for future city growth and the city has employed consultants to help them with this detailed work.

Harrison et al (2009) propose that the spatial discourse developed by UCT academics, consisting of nodes, corridors and urban edges related to the production of a compact city has continued to dominate planning in post-apartheid South African cities. This discourse shifted in the 1990s to include the influence of the neoliberal discourse of competitive, managed 'entrepreneurial' cities through the implementation of the GEAR policy in 1996 in South Africa. Here the influence of the market in determining the spatial form began to emerge and compete with the vision of the compact city.

Sharing information and data with the public is another function of GIS in Cape Town. The city has developed an interactive map whereby the public can search for data related to their wards[29]; census data; as well as many city reports, e.g. *Study on The Social Profile of Residents of Three Selected Informal Settlements in Cape Town*. In 2003, a Contact Centre was established to deal with queries related to following core services: rates, electricity, sewage, water and refuse removal.

Knowledge management in urban planning: actors and networks

The main actors involved in knowledge management in urban planning are the City of Cape Town Municipality and the consultants they commission to produce plans and maps. The Strategic Development Information (SDI) and Geographic Information System (GIS) Department provide the data needed to makes decisions with regard to Cape Town's range of development needs (www.capetown.gov.za). The goal of the Strategic Development Information and GIS Department is stated as follows: "to strengthen the use of information and knowledge in contributing to the future development of Cape Town. We aim to achieve this through:

- Developing systems and processes to promote the sharing of information and knowledge across the organisation.
- Sharing innovative and best practices.
- Conducting research, relevant analysis and interpretation of information".

The city's website indicates that there are four branches in this department: Strategic Information; Corporate GIS: Information and Knowledge Strategy and Knowledge Resources and Support. Strategic Information provides information, surveys and policy support for the entire city's urban development work. For this it compiles demographic and socio-economic data. The Corporate Branch has the important task of both providing, managing and co-ordinating spatial information for the city, including property related information[30]. Within Corporate GIS the Geomatics section provides and manages data related to the survey data for properties; aerial photography; satellite imagery; GPS surveys for engineering, topological maps; digital terrain models and land use activity data for commercial and industrial properties[31]. Spatial data is also available to the public who can purchase hard copy and electronic data of various kinds.

The development of the city strategy with regard to information and knowledge is the task of the Information and Knowledge Strategy Branch, while the fourth branch, Knowledge Resources and Support manages a Knowledge Resource Centre to encourage and enable an easy access to spatial information in the city.

Different departments within the city also serve as leading actors in the use of ICT-GIS and develop innovative methods to contribute to urban development. The Water Services department uses the standardised GIS platform to 'collect, analyse, and model spatial data to optimize water conservation and demand strategies' (Bauman, 2008) in the context of Cape Town's limited water resources and a fast growing population. Spatial knowledge has played a critical role on the post-apartheid context of transformation where the municipality plays the role of the developmental state. The Municipality has a very well developed GIS system which is being used increasingly.

Consultants play an important role in undertaking work for various departments. They are commissioned to undertake analysis of the municipal databases, adding value to the products. A large and growing number of GIS professionals are also employed within the Municipality. The city also has a link with UCT through the African Centre for Cities 'Citylab' research project which aims to:

- Bring together researchers and practitioners in the City of Cape Town from different disciplines and professions

29 https://www.capetown.gov.za/en/stats/Pages/CityMapViewerMain.aspx

30 https://www.capetown.gov.za/en/stats/Pages/default.aspx

31 https://www.capetown.gov.za/en/stats/Pages/default.aspx

- Learn from practice and dissemination knowledge that will build sustainable human settlements[32].

Spatial knowledge in the city is mainly produced in the form of maps and associated reports, e.g. Spatial Development Plans, poverty maps, facility and service maps. Infrastructure units have all the main infrastructural assets of the city captured in the GIS. The GIS is also extremely important in managing property ownership via the cadastral maps linked to the valuation roll as a critical tool in managing and collecting rates in the city – the most important source of income.

Thus the ICT-GIS based knowledge system for development decision-making is a very powerful tool in the Municipality and has contributed to the successful delivery of housing and services and achieving the goals of redistribution and financial stability.

Knowledge building, use and contestation

Since the introduction of ICT-GIS based knowledge management in the Municipality in the early 1990s, there has been a steady increase in the use of these systems, with all units, particularly the technical delivery units in the city, using these tools. Although all data is now managed centrally, individual departments have their own GIS systems. One of the main bodies of knowledge produced via GIS is the municipality's hierarchy of plans, including the city-wide Spatial Development Framework (SDF). This and the Urban Edge and Coastal Edge as spatial planning tools are discussed below. Most of these plans are the outcome of predominantly technical rather than participatory processes, although the latter is being upgraded. This is followed by a discussion of two models which are used to locate infrastructure and services in the city.

The Cape Town Spatial Development Framework

The Cape Town Spatial Development Framework (SDF) is a key component of the Municipality's Integrated Development Plan that sets out the long term (20 year) desired spatial form and structure of the Cape Town metropolitan area. The SDF report describes the overall intention of the SDF as follows:

"to guide and manage urban growth, and to balance competing land use demands, by putting in place a long-term, logical development path that will shape the spatial form and structure of Cape Town. In the context of climate change and resource depletion, including finite oil resources, the future growth path needs to underline the importance of sustainable future growth" (City of Cape Town, 2012a: 8).

The SDF heads up the city's hierarchy of plans, consisting of the SDF (20 year time frame), eight Spatial Development Plans (10 year time frame), Local Spatial Plans, strategy and policy documents and development guidelines (see Table 1). The SDF went through a rigorous public process with three rounds of public participation over a four year period from 2007-2011, and was approved by the Municipality and the Western Cape Provincial Government in May 2012. The custodian and driver of the SDF and the eight district Spatial Development Plans is the city's Department of Spatial Planning and Urban Design, under the Directorate of Economic, Environmental and Spatial Planning, with inputs from other departments including the Environmental Resource Management. The Spatial Development (Table 5.1.1: The City of Cape Town's hierarchy of plans)

The development of the Cape Town SDF has been a lengthy and complex process. Figure 2 from the SDF report (City of Cape Town, 2012a) shows the shift from a complex and messy planning terrain prior to the creation of the Unicity to the hierarchy of plans produced in the post-2000 phase. In the 1990s, a long-term spatial plan called the Metropolitan Spatial Development Framework (MSDF) was developed to replace the apartheid-era Guide Plans and to guide the growth of metropolitan Cape Town. However, the MSDF remained in draft form due to the hiatus in municipal strategic planning during the challenging period of the late 1990s and 2000s relating to the transition to the Unicity municipal government structure. In 2001, an interim redraft of the MSDF was adopted as city policy. In 2005, the Municipality reviewed the previous MSDF and other metropolitan planning initiatives and began to do the strategic planning work that would lead to the development of a new SDF, finally adopted in 2012.

It is worth reflecting here for a moment on some of the key elements of the MSDF, the precursor to the 2012 SDF. As a structure plan, the MSDF was meant to be a conceptual plan, showing where investment should take place, rather than being merely a map of the city 20 years hence. However, it has been criticised for being a map, rather than a plan, with no tools or processes to achieve the future vision (Turok and Watson, 2001). Figure 3 shows the MSDF in hand drawn map form which was produced prior to the use of GIS for spatial planning in the city.

32 http://www.africancentreforcities.net/programme/citylab/

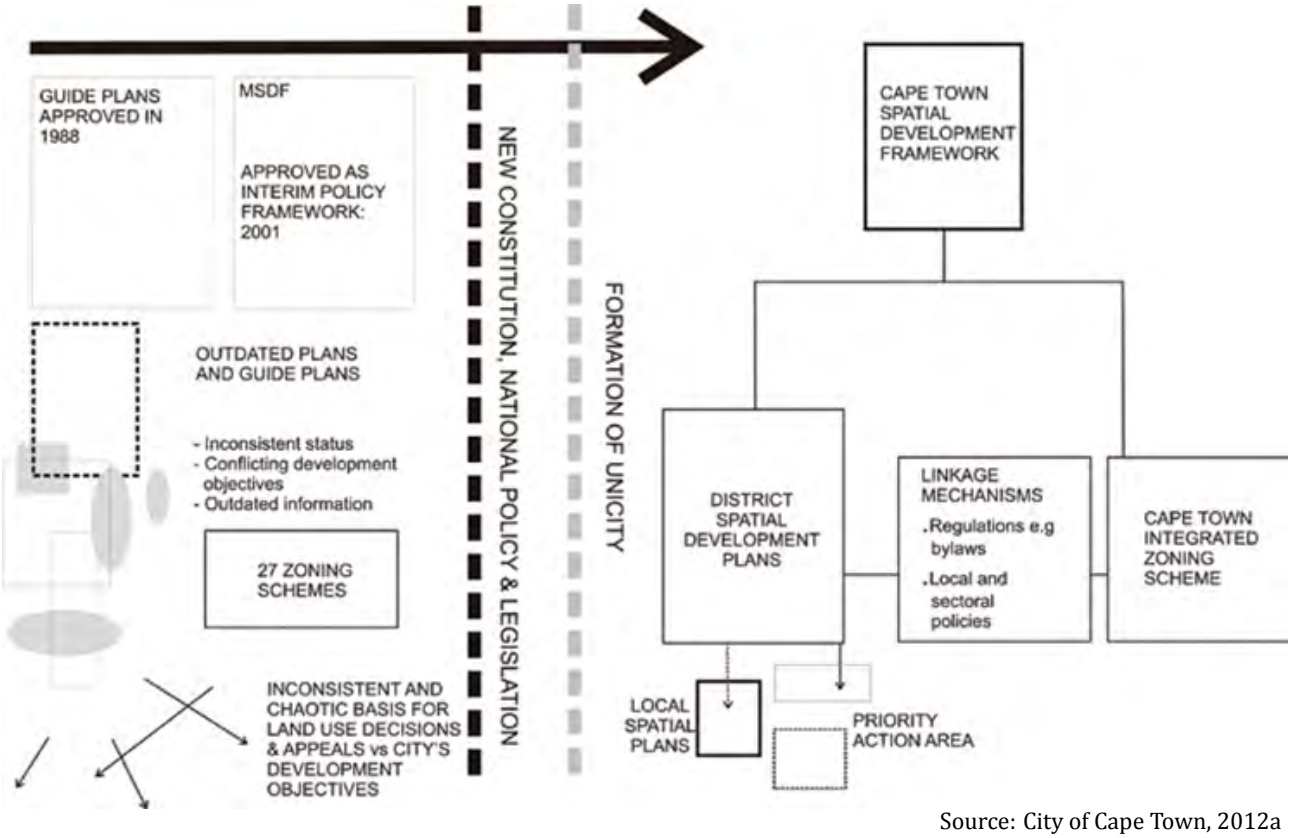
Table 5.1.1: Framework page on the Municipality's website[33] provides an interface with the public where the SDF, District SDPs and Local Plans can be downloaded.

Spatial plan / policy	Purpose	What it is replacing or adding to	Who approves	Legislation or policy that guides approval
CTSDF	Long-term (20+ years) citywide spatial structuring elements and plans, and overarching policy framework.	Guide Plans, Metropolitan Spatial Development Framework and subregional plans approved in terms of section 4(6) of LUPO.	PGWC Council	MSA LUPO (section 4(6)) NHRA World Heritage Act
District SDP	Medium-term (10+ years) district-level spatial development plans which indicate proposed land used in new development areas, urban restructuring and upgrade interventions.	District and local structure plans approved in terms of section 4(6) and 4(10) of LUPO.	Council	LUPO (section 4(10)) - provision on the lapsing of structure plans after a specified time frame; NHRA, World Heritage Act City's system of delegation
Local Spatial Plans	Detailed SDF related to, for example, the management of land users, and detailed local-level planning such as density plan	District and local structure plans approved in terms of section 4(6) and 4(10) of LUPO.	Council	LUPO (section 4(10)) City's system of delegation NHRA
Strategy / policy documents	Detailed issue / land use specific policy parameters that should determine land use decisions, such as densification, urban edge, guesthouse and bed-and-breakfast (B&R) policy.	Will replace or complement existing policies.	Economic, Environment and Spatial Planning Portfolio Committee (EESPCO) and/or Council	City's system of delegation
Development guidelines	Detailed guidelines that should inform land use decisions, such as fire protection guidelines and urban design guidelines (for example tall buildings guidelines).	Will replace or complement existing policies.	EESPO (if it does not effect other sectors) Council, if other sectors are affected	City's system of delegation

Source: City of Cape Town, 2012a: 11

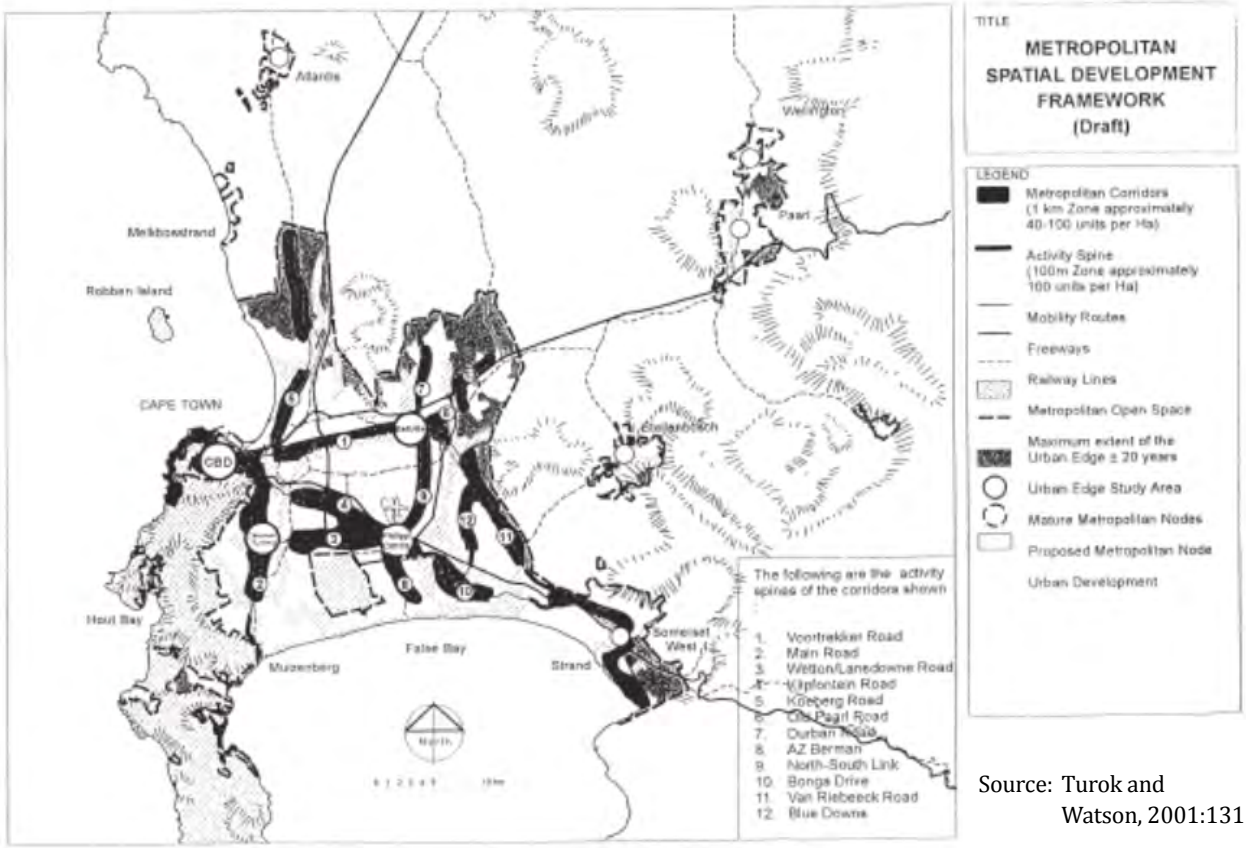
33 https://www.capetown.gov.za/en/sdf/Pages/default.aspx

Figure 5.1.2: Reforming the Cape Town spatial planning landscape



Source: City of Cape Town, 2012a

Figure 5.1.3: The Metropolitan Spatial Development Framework.



Source: Turok and Watson, 2001:131

In the post-1994 period, there was a shift to the 'compact city' approach with a more integrated strategic approach. Progressive planning professionals in South Africa were searching for an alternative to the racially based apartheid planning and adopted this approach popular in planning in the late 1980s. The new post-apartheid spatial model was based on the spatial concepts of 'New Urbanism', which structured the 1996 MSDF, namely:

- Corridors (public transport based);
- The urban edge to contain sprawl, encourage higher densities and promote a compact city;
- New nodes to supply areas with no services and commercial activities;
- Open space systems;
- Pedestrianised movement systems;
- Mixed land use; and
- Spatial integration which was opposite to the segregated apartheid city.

These spatial concepts put forward in the MSDF have retained their value and continue to be reflected in the current 2012 SDF.

The SDF development process

In 2006, the City embarked on a process of developing a new Cape Town SDF. The first step was *Future Cape Town*, an internal document with proposals concerning the strategic direction of the SDF. A Strategic Impact Assessment of the environmental and heritage impacts of the *Future Cape Town* strategy followed, together with the process to develop eight District Plans, which included Environmental Management Frameworks (EMFs), for the City's eight planning districts. Both the District Plans and EMFs were developed in GIS, and fed into the final SDF for the whole municipal area.

The Municipality adopted a "rigorous and inclusive public engagement process" for developing both the SDF and the District SDPs (City of Cape Town, 2012a:13). Three extensive public participation phases were conducted between 2008 and 2012 (City of Cape Town 2011; Walker interview):

Phase 1: The launch of the SDF process and establishment of issues and principles. Between February and April 2008, twenty-six Sub-Council Stakeholder Workshops, a city-wide workshop and workshops with sub-council members were staged in order to engage with the public (1 299 people).

Phase 2: The draft SDF Technical Report was advertised for public comment. Discussions were held on the spatial concepts employed which included the draft densification and densification policies. The District SDPs were also presented at this stage. The Provincial Government of the Western Cape reviewed the draft plans and policies and confirmed that the City could proceed with the third round of public participation.

Phase 3: The Final Draft Cape Town SDF was sent to all sub-councils in November 2010 which elicited 1 763 issue specific written comments (City of Cape Town, 2011). It was then presented at public hearings in January 2011 to discuss how the comments raised from Phase 2 had been incorporated and to give an opportunity for the public's final comments. Particular attention was focused on the proposed urban edge amendments and the coastal edge and densification strategies. The following public participation mechanisms took place: 23 district level workshops, 22 sub-council based open days, six city-wide interest group workshops, a meeting with government departments and state-owned enterprises, and sub-council reports and presentations (1 150 people).

The intensive public participation process allowed the views and concerns of the public and interest groups, such as the Business Forum, to be taken into consideration in the SDF. There was much negotiation and deliberation with the Business Forum before they accepted the Urban Edge as an element in the SDF as this would have important implications for financial investment in the city. However, they finally agreed and "realized that this was good for the city" (Walker, interview). In this way, lay and professional embedded knowledge from civil society could be incorporated into the SDF as a municipal knowledge product, approved in May 2012.

According to Walker (interview) the development of the SDF involved considerable challenges, hard work and consultation. It was a lengthy discursive process that resulted in several reviews of the SDF as it evolved, including the commissioning of additional work to fill important knowledge gaps. For example, in 2010, when the 4th draft of the SDF had been completed, an important expert review was commissioned that raised the need for further "systematic and comprehensive understanding" of the city's space economy. Other concerns included the decentralisation of public and private development, which is challenging the concept of the urban edge, e.g. Century City, north of the city, which also undermines the notion of corridors; and the informalisation of the economy (McGaffen, interview). This requirement for additional research to inform the SDF points to a lack of good economic data at a sub-metropolitan level to inform strategic spatial planning.

Key SDF concepts

Several elements of the 'urban design paradigm', derived from the concept of New Urbanism (edge, space, nodes and corridors) and clearly evident in the 1996/2001 MSDF, were carried over into the 2012 SDF. The SDF continues to use the language of 'urban efficiency' and has inherited the spatial geometric grid (land use/nodes/corridors) which has become entangled with the 'transformation' and 'neo-liberal economic development' discourses. According to Walker (interview), the production of the SDF has been 'revolutionised' since the advent of GIS in the early 2000s. GIS has been used to 'warp' the grid to fit the realities of urban development in Cape Town. Due to the large environmental lobby in the city, environment features strongly in the SDF as it is one of Cape Town's major assets.

The SDF identifies the following key interrelated structuring elements that "have been developed to provide overall direction to the future spatial form, structure and development of the city" (City of Cape Town, 2012a: 29-36):

- Resilience and adaptability
- A city within a region
- Natural assets
- A multi-directional accessibility grid
- Areas of land use intensification
- Urban growth management informants – development edges
- Destination places.

The SDF encourages land use intensification on and adjacent to the accessibility grid, particularly the primary accessibility grid (corridors and routes), to establish thresholds for sustainable, cost-effective, efficient public transport and to generate accessible economic opportunities. Land use intensification can take a variety of spatial forms, including development corridors, strip development, urban nodes and civic precincts (City of Cape Town, 2012a). All of this is mapped and assessed through GIS.

Two of the most important elements of the SDF are the development edges, the Urban Edge and the Coastal Edge. The development edges serve to promote land use intensification through containing urban growth within defined areas, as well as protecting environmental resources.

The Urban Edge is defined as "a medium- to long-term edge line, where the line has been demarcated in such a position as to phase urban growth appropriately or to protect natural resources" (City of Cape Town, 2012a: 35). The SDF requires that medium-term growth (10–15 years) should be prioritised within the Urban Edge, while in the longer term (15–50 years); the Municipality will need to adjust the Urban Edge line based on the agreed growth direction of the city. The Coastal Edge is defined as "a demarcated area around the coast in such a position as to limit urban development, mainly to protect coastal resources and avoid hazards and financial risks pertaining to areas at risk of flooding" (Colenbrander et al, 2012: page number). The following section provides further detail on how these spatial concepts were developed.

The Urban Edge

The Urban Edge is defined by Table Mountain, the Metropolitan Open Space System and the northern outer edge (refer to red line in Figure 5.1.4) where it serves to contain urban sprawl and protect agricultural and ecological resources. In accordance with Lefebvre's notion of representational space, the Urban Edge is a very powerful element of abstract space which directly influences the 'everyday spaces' of Cape Town residents (see Watson, 2002: 112). It is a much contested tool as it prevents investment in urban development at the northern periphery of the city; where there is political pressure to expand.

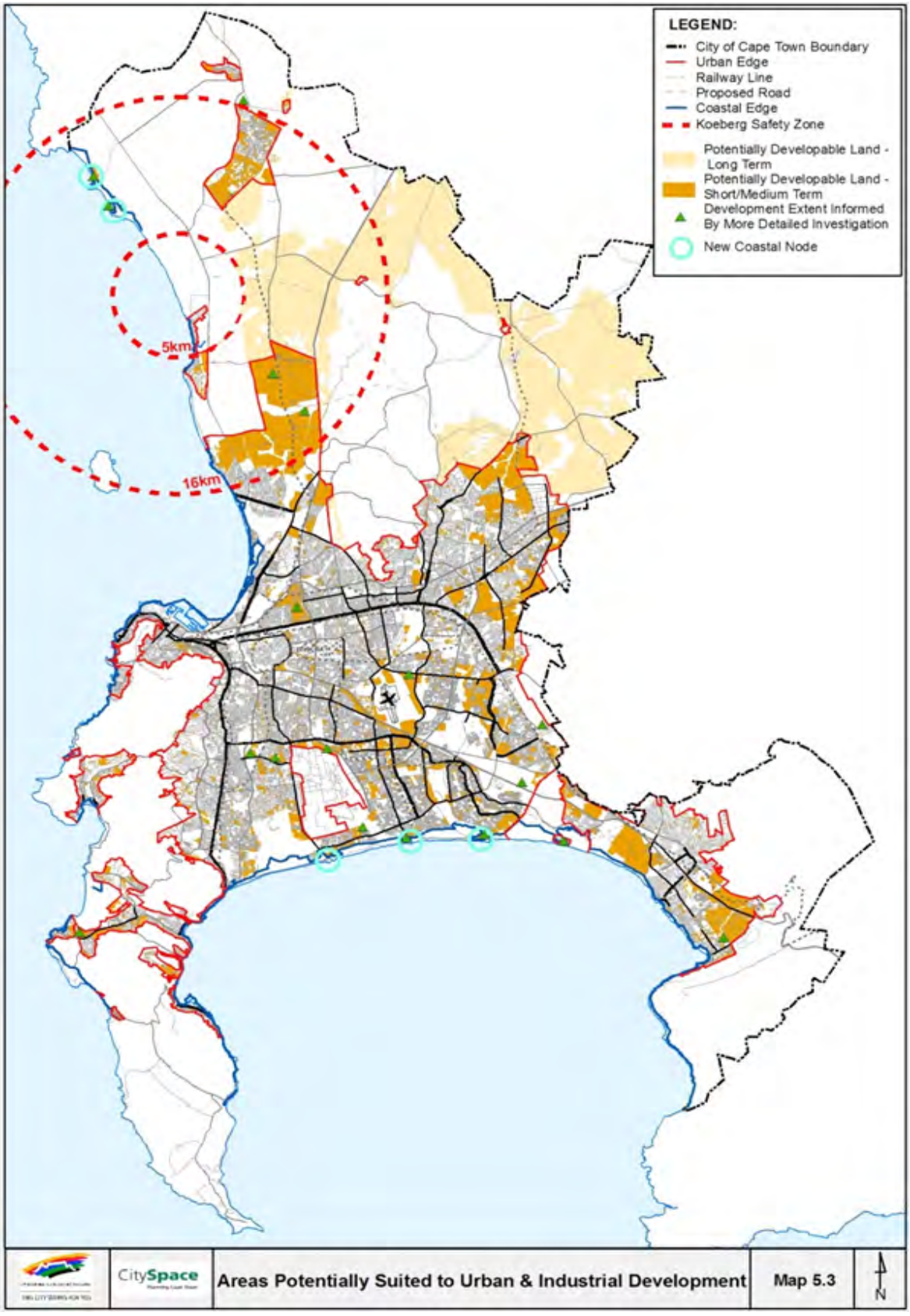
The Urban Edge is directly linked to the Municipality's Densification Policy, approved in 2012 which responds to the City's goal to create a sustainable, compact city. The Policy promotes densification because it reduces the consumption of valuable/non-renewable resources, e.g. agricultural land, non-renewable fuels, and valuable biodiversity areas; and it supports the development of a viable public transport system due to higher densities and increased population thresholds.

The Densification Policy presents alternatives through which densification can be achieved, which will influence the form urban development takes within the Urban Edge. The City of Cape Town aims to improve residential densification per hectare through a densification programme that includes the identification of public and private land within the urban edge, planning the development of infill housing, and identifying opportunities for the densification of urban corridors and nodes. All of these activities will use GIS analysis.

The Coastal Edge

The other important development edge used in the SDF is the Coastal Edge, delineated by the Municipality's Environmental Resource Management Department using

Figure 5.1.4: Development areas bound by the Urban Edge and the Coastal Edge[34]



Source: City of Cape Town, 2013: website: https://www.capetown.gov.za/en/sdf/Pages/Download%20maps.aspx)

34 https://www.capetown.gov.za/en/sdf/PublishingImages/Maps_2012/Areas_Potentially_Suited_to_Urban_Dev.jpg

its Environmental Information System (EIS) and then fed into the SDF process. The EIS provides spatial environmental information in digital, graphical format using GIS. Essentially, GIS is used as a tool for managing coastal risk in locations where there is either inappropriate development in the coastal zone or where there are vulnerable locations. The GIS is used to define the 'coastal protection zone', and in so doing identify the 'risk space'. The identification of the 'risk spaces' around the coast has become increasingly important due to potential impacts on urban coastal development as a result of climate change.

The National Environmental Management Act (1998) and the Integrated Coastal Management Act (2008) require that coastal development setback lines are determined in all municipalities. The Cape Town Municipality began a process of delineating the coastal set-back line in 2007, and is "leading the way" in setting this line in the Western Cape. This delineation approach intended to achieve five primary objectives: "a) promote access to the coast; b) promote increased degrees of integrated coastal management within the City; c) reduce risk to the City; d) ensure that the socio-economic opportunities the coast currently provides are retained and enhanced in perpetuity; and e) ensure the conservation of remaining functional coastal ecosystems" (City of Cape Town, 2012c: 6).

In order to be able to delineate the coastal set-back line (otherwise referred to as the Coastal Edge in the SDF), the City completed an intensive Sea-Level Rise Risk Assessment (SLRRA) in 2009. This was part of a series of research projects conducted by a *Climate Change Think Tank* set up in Cape Town as a forum of exchange and learning between 40 academics, practitioners, politicians and civil society members. All these projects involve the use of GIS in predicting vulnerable areas along the coastline under different circumstances and drawing the coastal edge as a management tool.

The Municipality adopted a combination of biological and socio-institutional approaches in order to delineate the coastal set-back line, based on the understanding that the social, economic and environmental context of the set-back line be taken into consideration. In this regard the Cape Town approach departed from that of the Western Cape Province and the Overberg District, whose set-back lines were based more narrowly on knowledge about physical coastal processes. The City of Cape Town approach was based on a relational concept of space rather than the physical concept of space, and embraced a 'trans-disciplinary and broadly participatory approach'. Some of the knowledge contained within this 'softer' approach included: equitable access to the coast; the aesthetics of the coast; and knowledge related to 'sense of place'. This more 'relational' approach examines the "connections between the social, economic and political dimensions" (Colenbrander, 2012c: 198).

The Municipality's delineation process resulted in a coastal set-back line (Coastal Edge in the SDF) which is of variable distance from the high water mark and suits local conditions, and which by necessity, required the participation and tacit knowledge of local people in the delineation process. Figure 5.1.5. indicates the specific delineation of the set back line (which delimits the Coastal Protection Zone[35]) on the coast of False Bay indicating that the set-back line is drawn close to the beach to allow recreational development at a coastal node to serve people living in the low income areas of the Cape Flats, such as Mitchell's Plain. Thus the socio-economic knowledge used here has serious implications for urban development, and coastal access and amenity for poorer people.

Cost Surface Model

Another GIS–based tool used by the Cape Town Municipality to direct development decision-making in the city is the Cost Surface Model. Originally developed by the CSIR for the eThekwini Municipality (Durban), the model is now used in both cities to guide decisions relating to the location of low-cost housing developments. As part of National Housing Policy, low-income formal housing is subsidised and thus the Municipality only pays for the infrastructure costs of servicing housing developments. The Cost Surface Model predicts the cost of providing bulk services to housing projects by location in order to select the least costly locations. In this way it promotes a compact city as infrastructure is much more expensive on the periphery. Since the model applies to the full range of services (see Figure 5.1.6), it provides for a more integrated decision-making process across the line functions of the municipality.

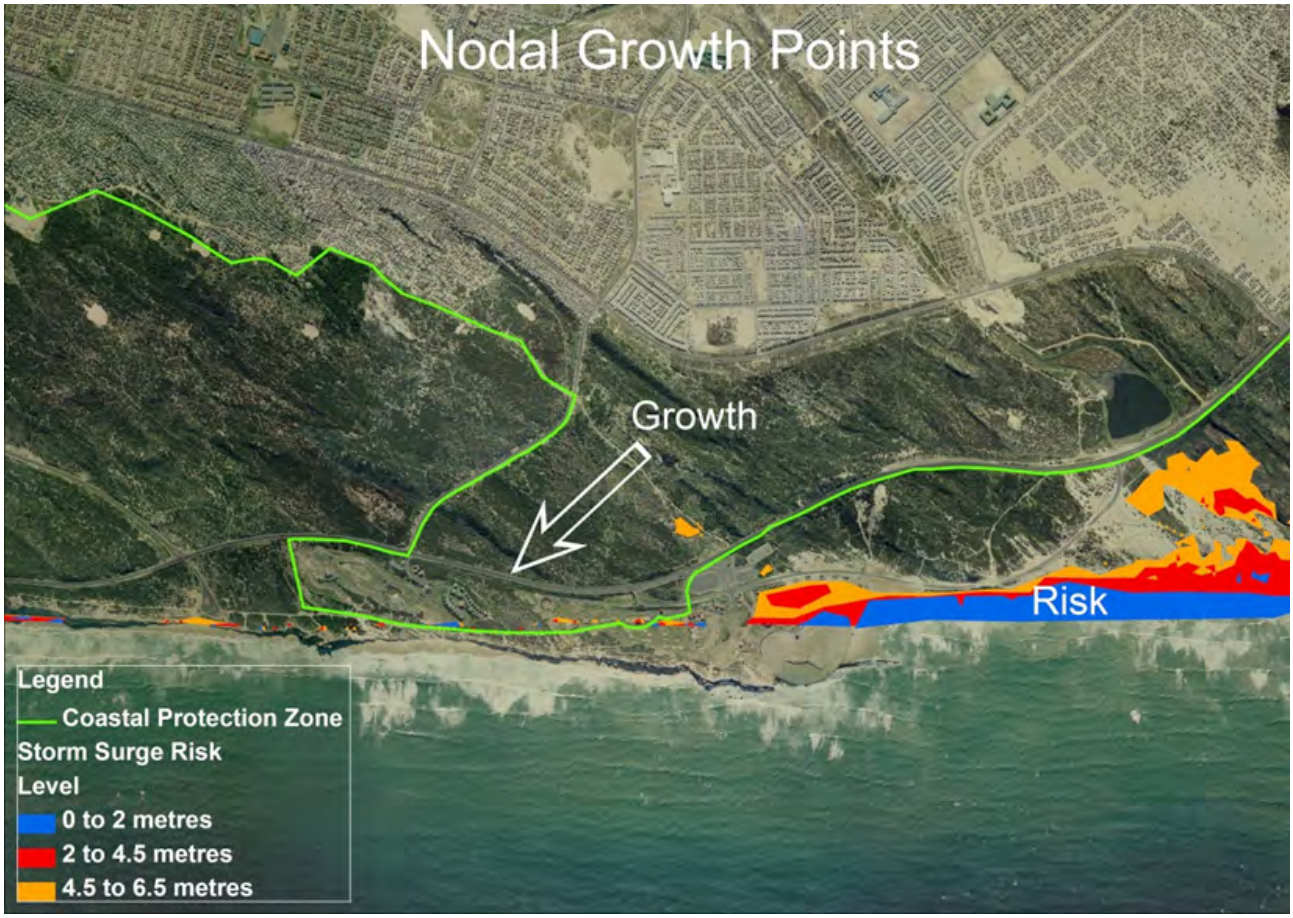
The CSIR developed the software package called '*SpacePlanner*' which uses a set of algorithms to predict cost of selected locations. It is used with GIS to assist in locating the cheapest location. The software is open access[36] and claims it can be used for the following purposes:

- "Forward planning – providing an equitable basis for allocation of land and capital budget resources together with limited locational guidelines for

35 The Coastal Protection Zone is the area between the High Water Mark (HWM) and the coastal set-back line (Coastal Edge).

36 http://spaceplanner.csir.co.za/

Figure 5.1.5: Boundary of Coastal Protection Zone, False Bay, Cape Town



Source: ...

distributing various types of facilities and public spaces;

- Development control – they provide guidance on the number of facilities required, and their scale and site requirements;
- Plan implementation – providing a yardstick to measure sufficiency or need of facilities on a broad scale;
- Improving quality of life – ensuring that a full range of facilities and recreational spaces is accessible to all communities, thus contributing significantly to improving the quality of lives in communities" (CSIR, ref).

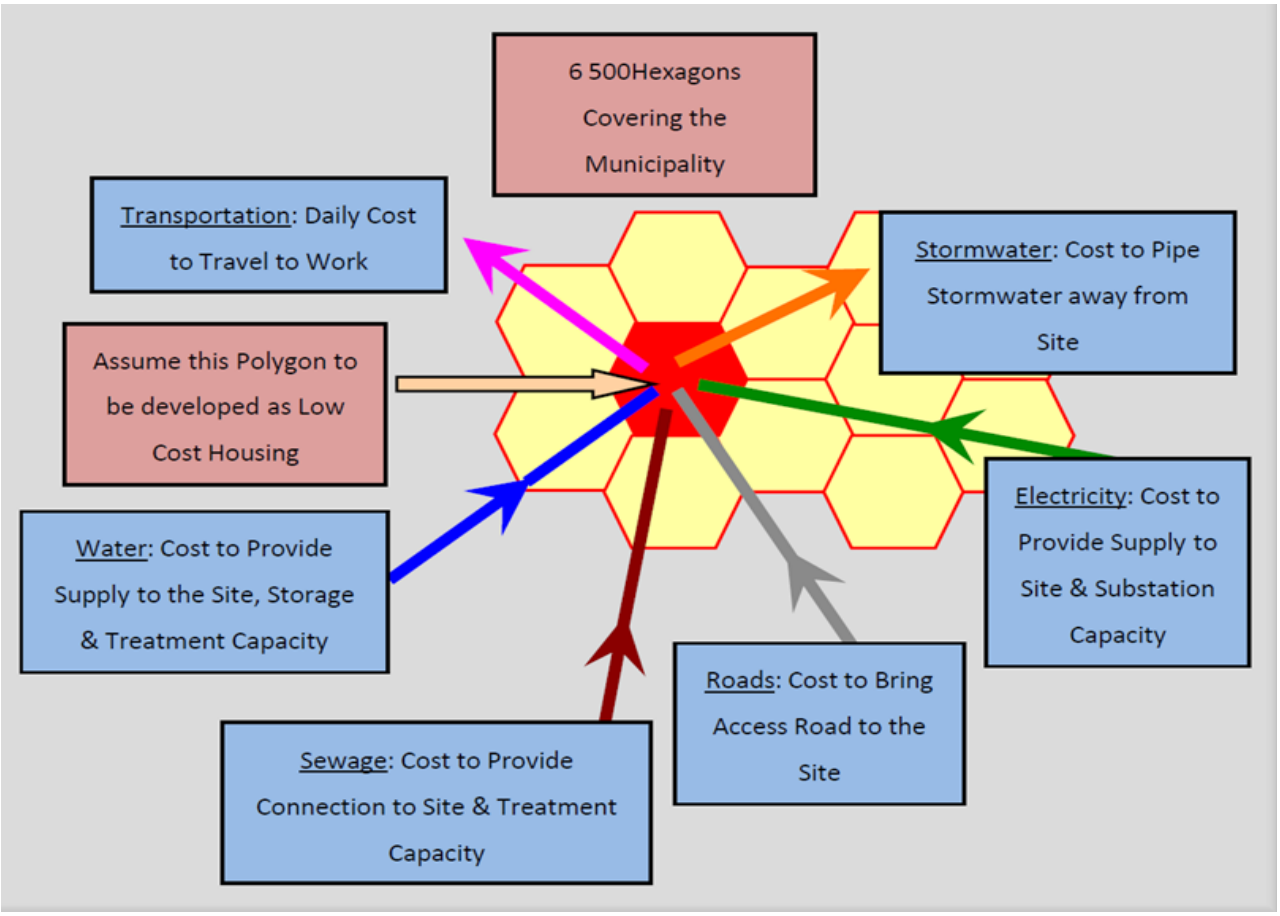
Figure 5.1.7 shows a map of Cape Town produced using the Cost Surface Model software showing the cost of infrastructure provision across the municipal area–dark red being the most expensive locations, grading to the lighter pink which are the least expensive areas in which the Municipality might invest in infrastructure.

Spatial knowledge produced through citizen participation processes

There has been a relatively low level and unsystematic approach to public participation in Cape Town, but in 2009 a Public Participation Policy Unit were put in place to increase engagement between the public and the state (Ruche, 2012). Furthermore, Ward Councils were initiated in 2007, providing opportunities for deliberation between citizens and state. Thus until relatively recently, there has been little feedback from civil society into the ICT-GIS knowledge system. By contrast, however, this level of engagement constitutes a significantly greater degree than that occurring in Durban.

An annual calendar was instituted in 2009 across all departments to log and systematise public participation in the city, and to monitor the processes (Ruche, 2012). Since then, Public Participation is mainly used as a financial monitoring tool aligned to budgeting and planning processes. Public Participation has been used in the IDP Revision processes since 2009, with the latter involving

Figure 5.1.6: Schematic diagram to show the predicted costs of services per unit area of the city



Source: ...

meetings across the city's 24 sub-council areas at which the city's *Five Pillars of Service Delivery* were presented for feedback. The public rated their services and chose the three most important goals for their areas from the 23 *Five Pillars of Service Delivery* objects.

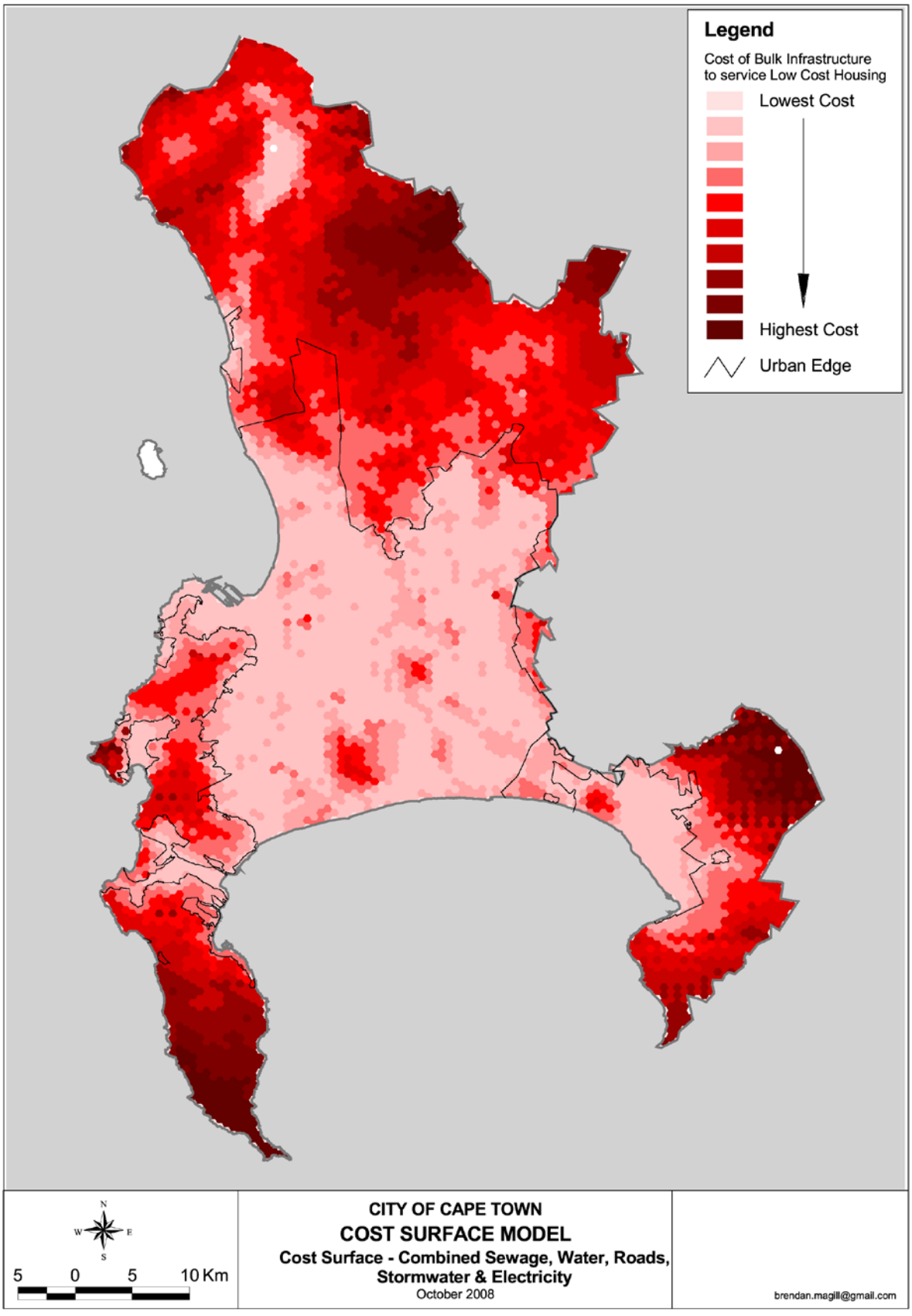
E-Governance is playing an increasing role in feeding ad-hoc information from civil society into databases. The City of Cape Town has a relatively advanced e-governance system. Citizens can pay accounts online, pay traffic fines, and make a number of queries regarding services[38]. In this way responses from the everyday lives of citizens in the city are captured into the system.

Conclusion

In conclusion, GIS as a technical tool is very powerful in urban development decision-making in Cape Town and has "revolutionised planning". GIS began to be used in the 1990s but it was only in the early 2000s that it became extensively used across the municipality, when spatial data became available to which to link census data. The different iterations of Cape Town's hierarchy of plans, including its Spatial Development Framework and eight Spatial Development Plans, have all been developed using GIS. The importance of the 'development edges' in the SDF cannot be underestimated as these spatially delineated lines on the map directly impact urban development decisions within the city. Linked to the inclusion of the Urban Edge in the SDF, the Municipality approved a densification policy to give effect to increasing densities within the urban edge. The City of Cape Town also included a Coastal Edge in the SDF steering decision-making related to development along the coast of the municipality (270km). These concepts form part of the 'compact city' discourse which is one of the dominant discourses for managing urban development in Cape Town, although the reality on the ground reveals that this vision has been contested in the process by business communities, as well as strengthened by the local knowledge of communities added to the Plan.

38 https://www.capetown.gov.za/en/Eservices/Pages/default.aspx

Figure 5.1.7: Cost Surface Model showing cost of combined services[37] per spatial unit in Cape Town



Source: ...

37 Combined services are sanitation, water, roads, storm water and electricity.

It is also important to understand that the integration of the City's GIS data with the SAP business system allows the city to spatially understand and implement processes to collect revenue for the city.

5.1.2. Durban, South Africa

Discourses and rationales for introducing ICT-GIS-based KM in urban governance; boundaries, work processes, mapping needs

ICT-GIS based knowledge management in eThekwini Municipality, its institutionalisation, uses, main drivers and related actors are a function of the global development of information technology since the late 1980s and the national and local socio-economic-political context in which it has emerged. Spatial knowledge has played a critical role in the post-apartheid context of transformation. The ICT-GIS system serves as a knowledge base to make development decisions relating to spatial restructuring of infrastructure, housing and service delivery and strategic planning, as well as providing information to citizens. Embedded in the IDP, it plays a crucial role in the pro-poor strategies of the Municipality and the strategic planning of a restructured post-1994 city, characterised by deeply entrenched spatial inequality. The Municipality has a very well developed GIS system, which is being used increasingly.

The good record of service delivery in the city can be partly attributed to the use of ICT-GIS based knowledge. It has also provided a foundational role in the excellent financial management of the city by providing an efficient tool for managing land parcels in the city and the collection of property rates, and in informing the spatial allocation of city budgets to address the needs in wards throughout the city. Although there still is a lack of institutional capacity in GIS in the city (Epstein, 31/8/2012), systems are being put in place to increase the institutional capacity for spatial knowledge creation within specific sectors. The local state in South Africa is mandated to provide 'developmental local government' and spatial knowledge production plays an increasingly important role in allowing eThekwini Municipality to meet this mandate.

After the Spatial Development Frameworks and Plans of the post-apartheid city, the finalization of the post-apartheid municipal boundaries, and the introduction of the Integrated Development Plan (IDP) (advocating both pro-poor and pro-growth urban development), the importance of spatial discourse has declined in strategic planning processes. However, the importance of spatial knowledge and spatial tools has increased as a means of delivering on the mandates of the IDP in addressing pro-poor issues.

The spatial discourse developed by UCT academics, consisting of nodes, corridors and urban edges is related to the idea of the 'compact city'. This discourse dominates planning in post-apartheid South African cities, including Durban. This discourse shifted in the 1990s to include the neoliberal discourse of competitive, managed cities through the GEAR policy. Lured by the promise of income from high rates derived from large-scale developments, many municipalities allowed such developments to go ahead, irrespective of whether they conformed to local development plans or not. The role of spatial discourse in driving development has been diluted since the early 2000s with the introduction of the IDP as the dominant planning tool and the discourse of 'integration'. "Integration is the leitmotif of post-apartheid planning…and is used to refer to social integration, spatial integration, institutional integration, policy coherence and the integration of planning and other governance processes" (Harrison et al, 2009, 139). However, separate ICT-GIS systems in the different Units of the Municipality has militated against integrated planning and service delivery.

The main use of the municipal ICT-GIS-based knowledge is to provide strategic information to policymakers as well as citizens. For policymakers, ICT-GIS is used for strategic planning (visioning); municipal boundary maintenance; increasing the effectiveness of the knowledge base for urban development decision-making; and the forward planning and delivery of infrastructure, housing, services and facilities, including interim services delivery–the delivery of physical infrastructure being the most important use.

Through needs assessments in the city Wards, the priority areas and location of development projects are mapped. Further GIS analysis makes it possible for budget allocations from line departments to be mapped, showing the spatial allocation of the budget. This process of needs assessment and providing spatial knowledge for targeting areas of greatest poverty and need are concentrated in the Engineering, Housing and Framework Planning units. ICT-GIS is viewed here an 'objective' knowledge base for development decision-making.

The redrawing of the eThekwini municipal boundaries was completed in 2002 and included a large portion of peri-urban land under communal tenure. The municipal area increased by 931 km^2 and 36 388 households, and the 2002 budget did not cover the provision of services to the newly incorporated, economically deprived peri-urban areas (Giraut and Maharaj, 2002). Although undertaken by the Municipal Demarcation Board, the final boundary decisions were then transferred to the eThekwini Municipality and used as its spatial limits. However, the use of GIS was

criticised by the public for using nationally generated statistical data as a basis for determining municipal boundaries. Communities complained that the use of GIS was a 'top-down approach' unable to integrate local conditions into its calculations and boundaries. Within the boundaries, the city has 103 Wards clustered into 23 zones. Years of work have gone into developing Ward and Zone boundaries, and when Zone boundaries are changed, much of this work is negated. The councillors in each Ward provide the political mechanism for feeding the needs of the Ward upward into the development decision-making processes through non-electoral democratic decision-making.

The Zones are the spatial units used for analysing citizen needs, by planning infrastructure and housing in accordance with areas of greatest need and allocating budgets more effectively. The Infrastructure cluster is responsible for the spatial analysis undertaken to determine the geography of needs and backlogs. The argument is that the Zones allow local government to plan at the sub-regional level rather than having to deal with the politics at the Ward level. The Zones are currently the spatial unit through which the abolition of apartheid spatial planning, social backlogs, economic programmes, employment and poverty reduction are being tackled. Planning and budgeting in the city is now geared to meeting the developmental priorities of each Zone. This is undertaken by a GIS analysis of the need in each Zone in relation to the current budget allocation.

The GIS analysis of population, service and socio-economic data has enabled the Municipality to provide a graphic portrayal of deprivations existing in the city. The use of 'hard data' provided by the GIS analysis reduces the politics associated with the allocation of the budget across the Municipality with its 103 Wards and 700 informal settlements – "we like evidence-based planning". Historically the Engineering Services have a stronger data base logic or approach than other municipal sectors. However, it is believed that the Municipality cannot do the planning properly without 'local community engagement' and a social compact with the communities.

Actors networks in spatial knowledge management for urban planning in Durban

The main actor network involved in knowledge management for urban planning is the eThekwini Municipality and the consultants they commission. The Municipality produces the main spatial databases, which are maintained and analysed by a range of Units in the Municipality. The main database manager is the Corporate GIS whose primary role is to maintain basic data layers, e.g. the cadastral and streets layers. GIS was first introduced into the city in the early 1990s when the main activity was building the spatial databases. In the 1990s, a number of Units relied on CAD for spatially representing elements in the city, which today have mostly been converted to GIS.

GIS is used across all the clusters of the municipal administration. Units in the clusters of Sustainable Development and City Enterprises and Human Settlements and Infrastructure have the most developed ICT-GIS systems. The Engineering, Water and Sanitation and to a lesser extent Housing Units are the strongest in terms of analysing and adapting the databases to serve their developmental goals. The Transport Authority has also developed its own GIS system.

The Water and Sanitation Unit adopted GIS early on, during 2000/2001, and are very confident in their data. This department is responsible for bulk water and sewerage infrastructure; for making projections for the infrastructure system (identifying the demands for new infrastructure); planning comprehensively from citywide water delivery plans to detailed level (very detailed drawings). eThekwini Municipality has won numerous awards for its pioneering work in the Water and Sanitation Department where it has analysed service provision using GIS analysis.

The Water and Sanitation Unit has delivered water and 90 000 waterless Urine Diversion toilets in the peri-urban areas of the city through the use of spatial zones delineated according to local community clusters and naming conventions. The use of GIS has been critical in the efficient delivery of these toilets, selecting local community members to deliver education programmes and undertaking opinion surveys, and for the management of maintenance programmes. Water and Sanitation is a key player in the city's development decision-making along with planning as together they are able to create scenarios for future development using GIS to determine a phased delivery of land for development and investment (Magill, 12/4/2013). The spatial boundary of the UDL (see earlier discussion) is an important factor in determining the direction and location of future growth and shows the waterborne sewerage edge. Planning of bulk infrastructure through GIS analysis therefore plays a critical role in determining future development.

While the tendency has been for these Units to work in 'silos', there is more recently emerging a more integrated way of working together in decision-making processes. Spatial knowledge management in the city via ICT-GIS based knowledge systems in the technical units is quite dominant since their mandate is to intervene in the physical space of the city which is amenable to GIS analysis (Magill,12/4/2013).

Private consultants are also important actors in producing spatial knowledge for the Municipality. Municipal Units commission the private sector to analyse municipal databases. A large and growing number of GIS professionals are also being employed within the Municipality. Furthermore, a range of consultants, including town and regional planners, urban design, engineering and environmental consultants who conduct work for the city make use of GIS in their assessments. For example, the company commissioned to develop the Verulam-Cornubia Local Area Plan, made extensive use of GIS data for spatial and infrastructure planning for the northern area of the city. There is scope for further analysis of the available spatial data by linking across Units in the Municipality, which would increase levels of integration. In addition to consultants, knowledge institutions (universities) are increasingly networking with the municipal units.

There is minimal feedback from civil society into the ICT-GIS knowledge system via the needs assessment at zone level (through councillors and ward committees). The only known community GIS is that of the South Durban Community Environmental Alliance (SDCEA) which has a simple GIS system and produces maps of the South Durban Basin describing the localised impacts of air pollution in the form of complaints and incidence maps (see Ranta, 2012; Scott, 2011). e-Governance is playing an increasing role in feeding ad-hoc information from residents into the databases via complaints lines, which then become data in the system (Geesink, 2012). In this way responses from the everyday lives of citizens in the city are brought into the municipal system.

Spatial knowledge in the city is also extremely important in making taxation processes more efficient and effective, managing property ownership via the cadastral maps linked to the valuation roll. This is a critical tool in the managing and collecting the rates in the city – the most important source of income.

Thus the ICT-GIS based knowledge system for development decision-making is a very powerful tool in the Municipality and has contributed to the successful delivery of housing and services and to achieve the goals of redistribution and financial stability.

Knowledge building, use and contestation

Since the introduction of ITC-GIS knowledge management systems in the Municipality in the early 1990s, there has been a steady increase in the use of these systems, with all units, particularly the technical delivery units in the city, using these tools. There is increasing exchange and integration between Units dominated by the technical units and planning. The importance of champions is evident with certain managers driving the application of the ITC-GIS knowledge and its use for more equitable decision-making due to the perceived 'objectivity' of ICT-GIS knowledge systems. The Water and Sanitation Unit has arguably the most powerful ICT-GIS system in the city with its own specially adapted database. The politicians have increasingly accepted the ICT-GIS production of spatial knowledge and this has allowed for high levels of service delivery in the city. Spatial knowledge that is produced by officials in the various units is presented to the councillors and the ultimate use of the information is through political decision-making. The success of ICT-GIS in the efficient delivery of services and infrastructure has led to more political support for this knowledge system.

One of the main bodies of knowledge produced via GIS is the municipality's hierarchy of plans, including the city-wide Spatial Development Framework (SDF), the four sub-regional Spatial Development Plans and Local Area Plans. The SDF and Spatial Development Plans are developed in-house by the Municipality (at times with planning consultant support) and then anchored in the Development Planning Unit's GIS system. They are developed iteratively by a Committee with representatives from all units in the Municipality and then sent to Council for approval. Local Area Plans and Functional Area Plans are generally produced by consultants commissioned by the Municipality. Apart from scrutiny during the annual review of the IDP, the SDF is not subject to any form of public consultation. There was limited public engagement towards the end of the SDP and LAP processes, at the level of information-sharing. Consequently, most of these plans can be considered the outcome of predominantly technical rather than participatory processes.

The SDF is the Municipality's key strategic spatial plan and a core component of the Integrated Development Plan. The SDF provides a spatial image of how the municipal area should be developed as envisaged by the IDP over the long term. The first SDF, which remained unchanged for five years) showed a much smaller central urban core surround by an urban edge. From 2008 the SDF started to reflect the city's expansion to the north. The national government approval for the development of the new airport and Dube Tradeport to the north of the city reflected a 'leap-frogging' of development beyond the urban edge. This northern growth trajectory was entrenched in the 2010 SDF with the new concept of the Urban Development Line (UDL), clearly indicating a shift in city policy to expand development in the north. The urban core has also expanded westwards around the Outer West suburbs and around the Cato Ridge/ Hammarsdale/Mpumalanga nodes.

The purpose of the UDL, as expressed in the city's SDF report is to promote a more compact, efficient and sustainable urban form in line with compact city thinking, and more recently, the low carbon city discourse. The line also corresponds to the outer limit at which the city can provide waterborne sewage, i.e. the edge of the bulk infrastructure delivery, and corresponds more or less with the former Durban Metropolitan Area boundary. The UDL assists the Municipality in managing city growth, containing urban sprawl and achieving its 'density targets'. At the same time it protects critical environmental services and the agricultural resources in the urban periphery upon which many households rely.

The UDL has expanded the urban development area contained by the original urban edge to include extensive areas to the north and west of the city. The extensive 'rural development area' (the area inland of the most developed part of the city), includes a number of planned rural development nodes and many areas of environmental sensitivity. The rural development area is predominantly peri-urban and mostly under traditional leadership. Because of the largely informal nature of these areas, and the fact that they lie outside the UDL, the Municipality has applied a policy of alternative methods of service delivery to these areas. Consequently, the UDL, as a key component of the GIS-generated SDF has become a powerful tool in the city's policy and practice around levels of service provision in the city.

The UDL has also had a significant impact on the city's approach to services infrastructure within the UDL in the urban growth areas of the city, particularly in the north due to the new international airport and the Dube Tradeport development. By entrenching the northern growth trajectory of the city through the UDL, the Municipality has had to significantly expand its services infrastructure to serve these new developments. The Spatial Development Frameworks, representing the future physical space of the city, have thus been reactive to developments taking place through a network of actors outside the Municipality – the private sector working with provincial and national government. In the northern corridor of eThekwini, a wide range of actors (the state, private sector, NGOs, CSOs and civil society) are actively shaping development in this zone through the discourses they construct and the spatial knowledge they produce. Hence, the municipal spatial knowledge frameworks for strategic future planning do not entirely lead future development and in many cases follow the lead of these other agents.

As part of the city's hierarchy of plans, four Spatial Development Plans (SDPs) have been produced for the city: the North, South, West and Central (refer to the plan of these four sub-regions at Figure 1). The SDPs provide more detailed spatial planning that informs the SDF from below as part of an iterative process. Many of the key components of the current SDF, including the UDL, emerged from the SDP development processes. The SDPs indicate the city's development priorities over the next 20 years for each of the sub-regions, and indicate development opportunities. In so doing, they direct future development and investment in a particular path. The SDPs also inform local level planning, and are in turn informed by local level planning when more detailed assessments at local level require fine-tuning of the SDPs in certain areas.

A review of all levels of spatial plans within the Municipality's hierarchy of plans indicates that the node and corridor discourse remains a powerful structuring discourse in framework planning. Figure 5.1.8. below shows the use of the node and corridor concepts in the development corridors on the North Zone: the coastal, urban and rural corridor.

At Local Area Plan (LAP) level, an assessment was undertaken as part of this research to uncover the

Figure 5.1.8: Development corridors in the North Zone



discourses and associated actors involved in the development of two spatial plans relating to the Cornubia mixed use mega-project development situated in the Northern Urban Development Corridor (Sutherland, et al, 2011; Sim, 2012). Firstly, planning consultants SSI produced the Verulam-Cornubia Local Area Plan (SSI, 2011a, 2011b) on behalf of the Municipality and as part of broader strategic planning for the Northern Urban Development Corridor. Concurrently, another planning consultant Iyer Urban Design Studio was commissioned by Tongaat Hulett Developments and the Municipality to produce the Cornubia Framework Plan (Iyer & Associates, 2011; Iyer, 23/1/2012) as a land use plan for the development of the Cornubia new town on this site.

A comparison between the land use maps contained in these two plans (which were produced using GIS by two different consultants on behalf of the Municipality) exhibit considerable areas of misalignment (compare Figure 5.1.9 with Figure 5.1.10). Nonetheless, despite this misalignment, both were approved on the same day by the Municipality at its Economic Development Committee meeting in March 2011. The processes of developing these plans, which were dominated by the relative power of key stakeholders over different issues, reflects the different spatial knowledge tools used by the planning consultants, the range of discourses of the key stakeholders, and the shifts in these discourses and their relative power over time. The spatial concepts embedded in these plans will have an impact on the everyday space of the lived world, once these spatial plans are translated into the 'bricks and mortar' Cornubia new town development. Of interest is to what extent each of the plans will inform the final outcome, i.e. which plan will exert the most power to be translated into reality. The research illustrates the tensions and conflicts that exist between different spatial knowledge producers, each using GIS and a range of concepts and discourses to represent the future of the physical reality of the north zone of the city. Politicians, officials, the private sector and consultants all contributed to the decision to approve these plans that emerged from an extended political and technical process (Sutherland, et al, 2011; Sim, 2012).

Further important applications of ICT-GIS by the Municipality are the two GIS-based models for strategic decision-making: the 'Accessibility Model' and the 'Cost Surface Model'. Both tools provide basic spatial information for decision-making regarding the location of infrastructure. The Infrastructure Cluster has been responsible for these two spatial models.

Figure 5.1.9: The Cornubia Framework Plan



Source: SSI, 2011

The 'Accessibility Model'

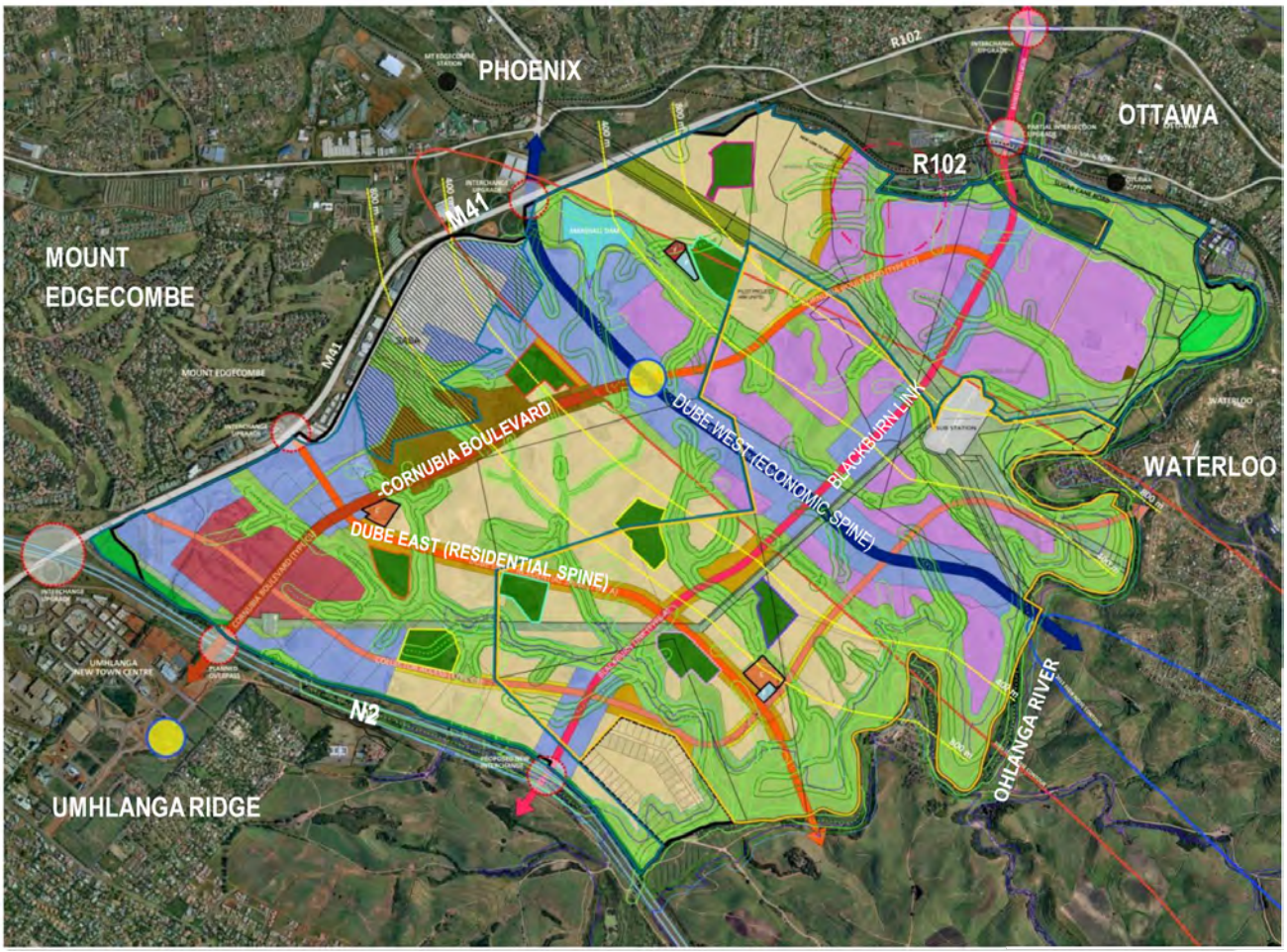
The Infrastructure Cluster has developed, with the assistance of the CSIR[39], a hierarchy of 27 nodes for the city ranging from the CBD to sub-metropolitan nodes to the rural nodes, classified according to their dominant function. The hierarchy of nodes is based on 'catchments of people' derived from analyzing population density data. Figure 5.1.11 shows the depiction of the higher level investment nodes within the denser urban area lying within the UDL[40]. This analysis forms the basis of the eThekwini Urban Spatial Agenda, which proposes that gap and affordable housing be located near the nodes which concentrate social services and facilities. The purpose of identifying Social Facility Nodes was to identify those locations where local, national and provincial levels of government must concentrate their investments in social facilities. These nodes must be points of high accessibility in order to serve as many residents as possible thereby improving the access to social services in the EMA.

The aim of the 'Accessibility Model' is to "direct and spatially locate the city's investment in social services and facilities" in a 'transparent' manner. Green et al (2009) state that:

39 The Council for Scientific and Industrial Research is a parastatal, whose main focus is to provide technical solutions for societal problems on a consultancy basis.

40 The UDL reflected in this map is an older version of the UDL. In the current version, the UDL has been pulled back in the northern part of the city (see Section 1).

Figure 5.1.10: The Cornubia Framework Plan



SHARED & CLUSTERED SOCIAL FACILITIES

- 2 PRIMARY S. + 1 SECONDARY S. + 4 SPORTSFIELDS + CLINIC + SWIMMING POOL
- COMM. HALL + CLINIC + 2 PRIMARY S. + 1 SECONDARY S. + 4 SPORTSFIELD + GOVERNMENT OFFICES + LIBRARY
- 2 PRIMARY S. + 1 SECONDARY S. + 4 SPORTSFIELDS + COMM. HALL
- 2 PRIMARY S. + 1 SECONDARY S. + 4 SPORTSFIELDS
- 2 PRIMARY S. + 1 SECONDARY S. + 4 SPORTSFIELDS + COMM. HALL
- 2 PRIMARY S. + 2 SPORTSFIELDS + LIBRARY + CLINIC
- COMM. HEALTH & ARV
- FIRE STATION
- POLICE STATION

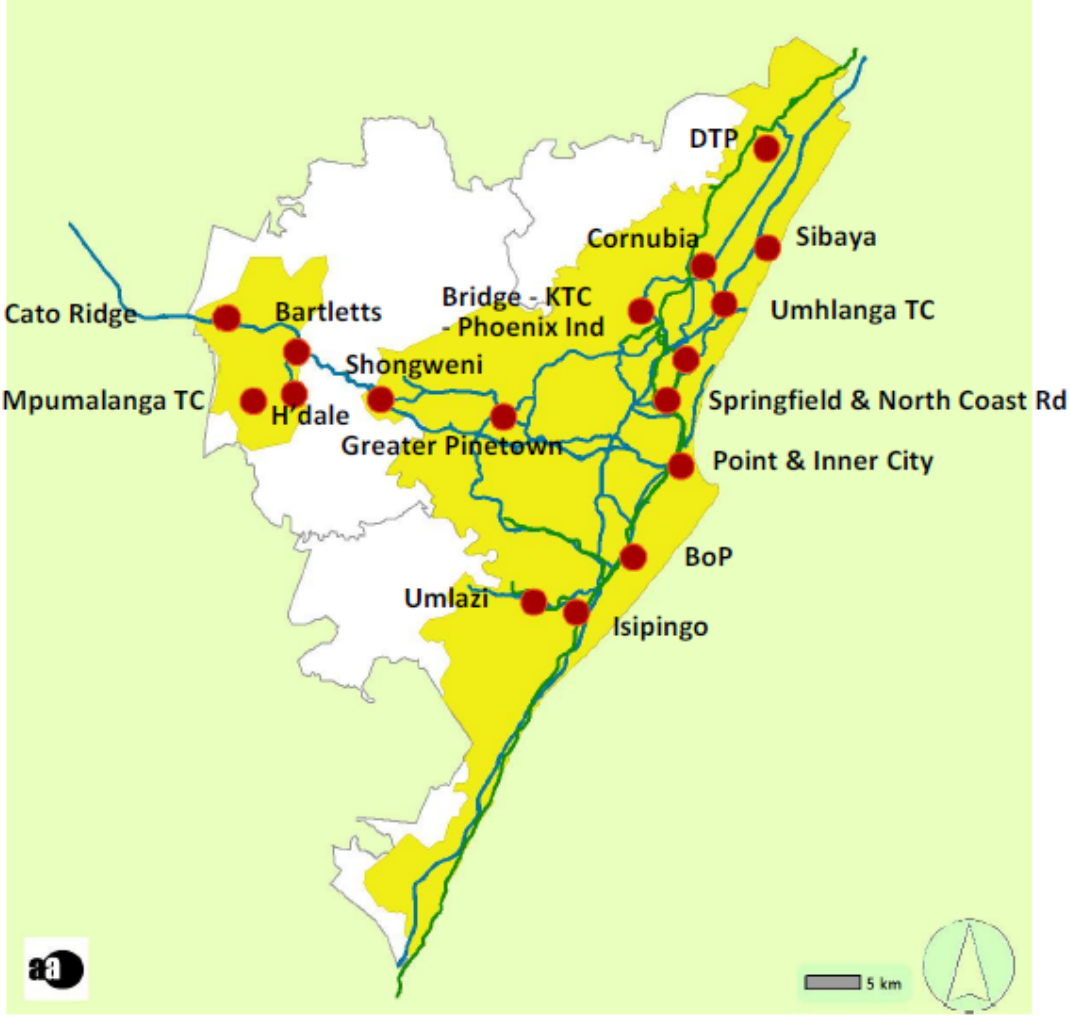
- CORNUBIA FRAMEWORK BOUNDARY
- OPEN SPACE
- HIGHWAY PLANTING
- SERVITUDE ZONE
- NURSERY
- WETLAND & 30M BUFFER

- DRAINAGE LINE & 30M BUFFER
- 100 YEAR FLOODLINE
- 40M BUFFER TO FLOODLINE
- 2015 55db NOISE CONTOUR
- 2035 55db NOISE CONTOUR
- POSSIBLE CEMETERY

- SASA LANDHOLDING AREA RESERVED FOR AGRICULUTRAL TESTING
- N2 FREEWAY (NATIONAL MOBILITY)
- EXISTING RAIL AND STATIONS
- TYPE A - PRIMARY ARTERIAL - 40m
- TYPE B - PUBLIC TRANSPORT ROUTE - 60m
- TYPE C1 - COLLECTOR ACCESS FOCUS ROUTE - 60m
- TYPE C2 - COLLECTOR ACCESS - 40m
- TYPE C3 - COLLECTOR ACCESS - 35m
- PLANNED INTERCHANGES / OVERPASS
- PT INTERMODAL POINT / NODE
- GENERAL BUSINESS (OFFICE / OFFICE PARK / RETAIL)
- MIXED USE 1
- MIXED USE 2
- HIGH DENSITY RESIDENTIAL 1
- MEDIUM DENSITY INTERFACE ZONE
- MEDIUM DENSITY HOUSING (1 + 2)
- LIGHT INDUSTRY
- 300m BUFFER TO TREATMENT WORKS

Source: Iyer Urban Design Studio, 2011

Figure 5.1.11: eThekwini Urban Spatial Agenda: Investment in higher level nodes within UDL



Source: ...

- "Advanced computing technologies which support GIS-based analysis, together with
- the application of the Service Access Planning approach developed by the CSIR,
- have been significant contributors to an effective and integrated means of identifying
- and eradicating facility backlogs, and developing equitable and defensible facility
- investment plans in post-apartheid South Africa".

The 'Accessibility Model' models the supply and demand for social facilities across the Metropolitan area and is able to predict the future social services requirements for housing. Based on this it is possible to formulate a plan over the next 5-10 years to provide adequate access for all citizens to the full range of social services. The aim is to cluster services in nodes and along corridors. Towards this goal, the Engineering Cluster and other social service departments have completed a full assessment of social facilities in the city. A model has been developed that matches the demand for facilities based on population density and distribution, with the supply of social services based on spatial location, capacity of service and the levels of accessibility based on public transport travel time. It provides quantitative information to aid decision-making and moves beyond the conceptual planning of the SDPs.

This modelling provides an 'objective' tool for allocating resources in an environment with many competing needs and limited resources. The 'Accessibility Model' adopted is based on GIS-based accessibility analysis. The data requirements for the analysis are: a detailed population layer to determine need; the transport network to gauge accessibility; and the capacity of each facility to determine supply. The 'Accessibility Model' gives an 'indication' of

needs rather than providing 'absolute knowledge'–and the interpretation of this need within local conditions remains important.

The Cost Surface Model

The eThekwini Municipality commissioned the development of a 'Cost Surface Model' to predict the cost of servicing any piece of land in the city, and has refined this model over the years to ensure that its modelling becomes more accurate as more information becomes available. The Housing Branch is using the 'Cost Surface Model' to make decisions on where to locate formal housing, based on the cost of the services for each location and greatly reducing the cost per unit. In the past, public housing was located all over the city depending on political pressure, and infrastructure would follow. Many sites were in peripheral areas with high infrastructure costs. National government pays for the top structure of housing and the Municipality pays for the bulk infrastructure.

The cost of service delivery is relatively low within the core of the city, but becomes more expensive in the more peripheral areas of the municipality. The transition from low to high cost aligns with the more recently constructed UDL concept in the Municipality's SDF (see City Report Durban), which demarcates the spatial limit of development according to infrastructure availability. Although this definition does not expressly mention cost, it is clear from the 'Cost Surface Model' that servicing costs play a critical role in defining urban versus rural level of infrastructure services.

The Municipality's housing provision is supplemented by a programme to provide interim services to informal settlements which are not likely to be rehoused in the near future. The Engineering cluster is responsible for the delivery of infrastructure to informal settlements in the metropolitan area. Figure 5.1.12 shows the location of clusters of interim service delivery sites (green).

GIS-based analysis is undertaken to prioritise and locate the settlements that will receive interim services delivery in each coming year. The overriding concern in the Infrastructure Cluster is being able to more efficiently locate and make decisions regarding such investment. It is felt that the decisions are more 'objective' and less political when using the spatial models for decision-making. GIS has thus been termed the 'anti-politics machine'. In the case of eThekwini Municipality it is lauded for being 'objective and rational'.

Spatial knowledge produced through citizen participation processes

There are minimal citizen initiatives providing spatial data for the ITC-GIS system of the Municipality, with most of the data from civil society entering the system via broad needs assessments per Zone. These are a very simple list of needs prioritized by residents in the Zone. Budget allocation is made according to needs analysis. There is current debate about where each Zone should get an equal amount to spend or whether priority needs are targeted.

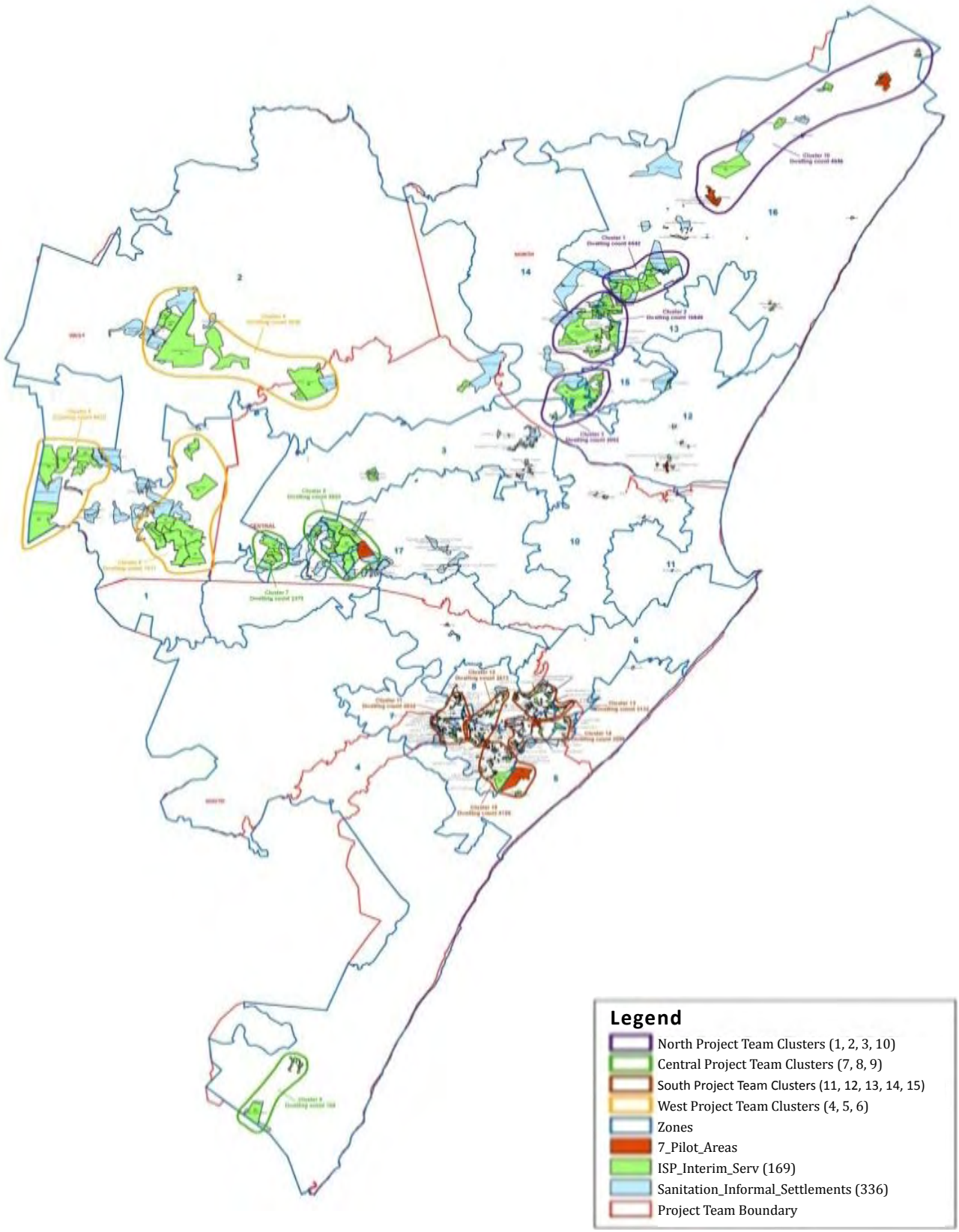
Historically, with the production of the first IDP in 2002, the boundaries of the city were established and the 103 Ward boundaries finalized. The Municipality set up what were known as the 'Big Mama' workshops through the Corporate Policy Unit, which were attended by representatives of the councilors and Ward committees for each city Ward. There were also sectorally based participation processes where workshops were held with NGOs and business (eThekwini Municipality, 2004, 85). The 'needs' of the ward would be presented mainly by the councillor who provided a very parochial set of needs.

The city acknowledges that "active citizen participation is time-consuming, costly and demanding" "erratic and event-dependent" (eThekwini Municipality, 2004, 83, 86) and in the subsequent IDP reviews much lower levels of participation occurred. The original workshops in 2002 used a 'blue sky' approach which was an open ended way of asking residents and groups what they needed with little consideration of the technical implications. These processes therefore provided few useful outputs and were replaced by the Infrastructure Cluster's more strategic approach implemented during the IDP (2007/2008) review process. The main ward issues, identified per ward by the councillors in the earlier process, were presented to the Ward Committee and then 'interrogated' and 'implementable solutions' proposed. Currently, Ward profiles are being re-worked to be "more palatable, less technical and more socially acceptable". Summarised versions of the Ward Profile and a map of its location are available online[41] and are frequently updated.

With regard to public participation in planning, the consultants drawing up Local Area and other Plans are mandated to record the outcomes of public participation as part of the planning process. It is generally accepted that these are very shallow forms of consultation rather than authentic participation.

41 The profile includes: demographic data; housing services & facilities; social backlogs; capital spend in the Ward and the ward priorities.

Figure 5.1.12: Location of the clusters of interim services sites



Source: eThekwini Municipality, 2012b

Spatial data is also included in the ICT-GIS databases in an ad hoc manner via e-governance platforms. This is increasingly playing an important role in keeping the Units in touch with realities experienced by citizens on the ground and represents a managerial approach to citizen engagement.

Reflections

The dominant knowledge base for urban decision-making is the ICT-GIS knowledge management system. Durban has a sophisticated spatial knowledge system via ICT-GIS platforms. This is growing in sophistication and outreach to citizens. With climate change and need to reduce travel, e-governance has become an important priority and is leading to innovative government to citizen interactions around service delivery using a managerial approach. This is also a product of the growing applications of information technology that are becoming available.

Because the GIS system maps physical space it is predominantly used in those Units whose mandate is to collect, manage and analyse data on the physical attributes of the city, i.e. spatial planning, housing and infrastructure delivery. These Units historically have a "stronger data base logic or approach than other sectors in the municipality" (Breetzke, 27/4/2013). It is also stronger in Units with champions. It is therefore important to note that knowledge based on 'softer' data, e.g. quality of life, is not as easily captured in such a system.

The technical Units actively build their own databases by collecting, storing, managing and analysing data related to their mandates, e.g. water and housing. Increasing use is made of outside consultants who play a very important role in analysing data for the various Units. It is these actors which derive the assumptions that lie behind the analysis and mapping process. There is potential for greater depth of analysis of the comprehensive databases and the Municipality is undertaking institutional restructuring to include more sector-based GIS and ICT specialists in its Units.

The visual portrayal of the dimensions of the Municipality in graphic format of maps plays an increasingly powerful role in development decision-making. GIS here is used for visioning and forward thinking. In the Framework Planning unit, however, although the SDPs portray the future of the city in broad terms, due to the power of the private sector and political interventions, developments on the ground often tend to 'create' the city, with the SDPs reacting to these changes in a form of reactive planning.

It is argued that the housing and infrastructure decision making based on GIS analysis is more equitable as it is objective rather than determined by political influence. Greater public participation would also lead to more equitable urban development planning.

ICT-GIS is accepted as a powerful, effective and reliable form of knowledge production across the city. However, increased capacity in the city would enable this spatial knowledge base to be used more effectively by political actors. Building capacity around ICT-GIS across the Municipality over time is critical to sustain the value of this tool in the city. Some officials argue that the city's ICT-GIS knowledge system is being used widely to fulfil the 'pro-poor' mandate of the city. However, it is also used extensively to enable land use decision-making fundamentally driven in response to private development interests. ICT-GIS therefore plays a critical role in both negotiating and undermining pro-poor and pro-growth processes, as it is used to capture issues critical to both agendas.

Megaprojects in the eThekwini Municipality are conceived of as a form of 'exceptional' development as they do not fit in with the accepted and mandated forward planning tool of the SDF. The SDPs reveal how the planning of the city has been driven by these large 'pro-growth' projects and contributed to the shape of the future city. Megaprojects need to fit into a sub-region of Municipality and thus have undertaken their own sub-regional planning using consultants. The ICT-GIS knowledge produced by consultants is often at odds with the city's development of its own hierarchy of plans, e.g. Tongaat- Hulett Developments' planning of Cornubia differing from the municipal Local Area Plan. Social and environmental provision is neglected in mega-project planning which produces a neo-liberal 'hyperreality'. A decline in spatial discourse in urban development also reduces the power of the framework planning knowledge base.

ICT-GIS knowledge is very important knowledge base for determining the location of water and sanitation provision. It is the dominant ICT-GIS knowledge system in the city and allows for rapid provision of services and meeting of service delivery mandates. There are innovative uses of e-governance tools to engage with civil society and add knowledge to the system from below. The Water and Sanitation Unit makes use of consultants, undertakes experimentation to fulfil delivery mandates, and is nationally and internationally recognised for its efforts. Academic and international NGO networks play an important role in building the analytical knowledge base through research. Strong link

with clients through field staff adds knowledge into data base. Water and Sanitation are becoming increasingly integrated into decision-making processes with Infrastructure, Housing and Framework Planning. These Units are engaged with the realities on the ground and responding through the building of a responsive ICT-GIS to fulfil mandates.

ICT-GIS knowledge also very important knowledge base for housing and infrastructure provision. With the GIS analysis and mapping of needs and backlogs – the geography of poverty – the location of interventions are prioritised and budgets allocated. Infrastructure, Housing and Framework Planning are increasingly undertaking integrated decision-making in the quest to provide quality living environments for all in the city.

Implications for the future: The ICT-GIS knowledge base in the Municipality is a sophisticated and powerful tool through which it has achieved significant progress in post-apartheid urban transformation in the physical environment. There is excellent knowledge available on a wide range of dimensions of the physical, economic, spatial, environment and administrative dimensions of the municipality. This is growing in extent and depth, along with the capacity and analytical capabilities the Municipality has at its disposal, and there is potential for further analytical processes. With this in place, there is a need to move towards setting in motion and budgeting for a process for the increased inclusion of participatory community knowledge. This will increase resilience and knowledge about the residents' living environments, the dominant issues in each Zone, and risks and vulnerability. The ICT-GIS systems are in place to capture and analyse participatory knowledge. What is needed is political will and the institutional arrangements to put this into place.

5.1.3. Guarulhos, Brazil

Discourses, framings

The main discourse behind introducing ICT-GIS-based knowledge management was a combination of government efficiency and transparency towards citizens, together with a greater participation of citizens and social inclusion since the PT became the dominant party in the city.

Special attention is given to stimulating citizen participation in all areas and levels of public administration as well as a stress on accountability and transparency.

Actors and networks in spatial knowledge management for urban planning in Guaruhlos

The creation of the GIS division in Guarulhos goes back to the mid 1990s, when a private company was hired to develop its first digital cartographic database (1993) and the SisGeo (Georeferenced Information System for Guarulhos) was formally created within the Municipal Secretary of Urban Planning (1997). From a traditional bureau devoted to producing maps and plotting to fulfill demands of various municipal departments, mainly planning, the division expanded to include two major areas: 1) geospatial data production and 2) data use and planning. In 2004, the geospatial data producing area moved to the Department for Information Systems and Telecommunication (DIT), directly connected to the Mayor's Cabinet. The newly created GIS division within DIT had the mandate to develop and implement a geospatial infrastructure (data, tools, and protocols) for the municipality as a whole. Within this new framework, in 2006 the WebGeo portal (http://webgeo.guarulhos.sp.gov.br/webgeo/index.php) was launched and since 2012 the CorporateGeo Platform (GeoCorporativo) is being developed. The CorporateGeo aims to provide corporate-based information and data covering administrative, socioeconomic, cultural and environmental issues. The basic goal is to create a secure data environment, minimize efforts and maximize results, improve data quality, provide added-value geospatial products (maps, indicators, metrics) and maintain an up-to-date data warehouse that is able to supply information for the increasing demands. Efficiency, transparency, participation, and inclusiveness are the corollaries informing this process.

The Secretary of Urban Development/Planning is a key actor in the Municipality in setting the basis for planning and governance, including knowledge management. This conforms to the pattern in which nowadays, the Secretary of Urban Development/Planning, along with Finance and Government, constitutes the core body of political power and the decision-making process at the local level in most municipalities. In 2001, the Labor Party (PT) elected for the first time the city mayor and since then has been in power. The current term of the PT mayor will end in 2016. From the outset, PT officials in Guarulhos brought into office a working philosophy anchored in three principles: 1) citizen participation; 2) consider the whole city and not only downtown and middle class areas, giving priority to the periphery and 3) administrative modernization. This was a novel approach since Guarulhos had been governed by a traditional oligarchy for decades.

Knowledge production, exchange, contestation, use

Prioritizing citizen participation and the periphery meant that planning could no longer be restricted to the office place and drawing table. It needed to include a variety of stakeholders and know the reality in several neighborhoods in the peripheral zones of Guarulhos. There was a need for information, data gathering and better understanding the processes at work that were shaping Guarulhos. The GIS department was central in this process.

Being Urban Development/Planning home of the GIS department in its early stages back in the 1990s, it is not surprising that knowledge management has gained a corporate dimension and the current GeoCorporate Platform is foreseen as key for planning. The GIS division has a central role in the GeoCorporate platform and has pushed for integration, also allowing departments to retain some control on uploading and sharing data as well as developing specific indicators for policy monitoring. Rather than being an IT project per se, the GeoCorporate Platform has been framed and foreseen as a broad information management project with direct benefits and added value for professionals implementing and monitoring public policy, including urban planning. This represents a shift in the planning mentality and way to run public business in Guarulhos. In a general sense, this shift is triggering significant changes in regard to involving actors and their role in data production and use.

Expert knowledge and codified knowledge are the core of knowledge production and management in urban Planning in Guarulhos. This is even more the case for spatial or geo-referenced data/information. The only exception of this is the Participatory Budget Office or department (OP). Among the handful of departments analyzed in our first field report, the OP office most directly deals with various forms of knowledge making a genuine and orchestrated effort to integrate different forms of knowledge such as tacit and expert/codified and managerial. The OP Office has been very effective in translating expert and technical language into formats and ordinary language that is easily understandable by less educated citizens. Also, their mandate and whole philosophy is routed on creating participatory spaces in a way that no other municipal department is able to do. Bringing technical departments to directly interact with citizens and explain projects under development has sensitized various departments to the importance of reaching out to the ordinary citizen and providing solid information. One good example, within the Department for Information Systems and Telecommunication (DIT), is the ongoing initiative for creating platforms, interfaces and tools for data management, flow and display on the Internet. These developments strongly focus on proving user-friendly interfaces mainly for less educated people with the main goal being offering wide access to information and basic services in less complicated and bureaucratic means.

These interfaces are basically a government to citizen (G2C) information flow rather than a comprehensive flow establishing dialogues and exchange including citizen to government (C2G) and citizen to citizen (C2C) exchanges. However, public officials report that even being just a portion of information exchange, these portals have eased ordinary citizen's daily lives in very significant means. Moreover, and perhaps more importantly, these portals have started to break barriers and provide missed links for building communication channels between citizens and public officials and the municipal bureaucracy at large. For the geospatial data culture in particular, the WebGeo portal launched in 2006 by the municipality and previously referred, was an important milestone in launching and strengthening this culture among officials and departments. Once the site was running, municipal departments started using it slowly but steadily and they became more interested and involved in providing data for the portal.

Important for our interest in urban governance and flows of knowledge is a particular outcome. Having this integrated database is providing tools and means to establish better informed conversations among public officials from various departments and outside the secretary boundaries. Also, it has improved dialogue and exchange with the private sector and professional associations with vested interests in zoning, development, planning and investment. The recently signed private concession for managing the international airport for the next 30 years and public-private partnerships for transportation network crossing Guarulhos are two potential areas to build upon these recent developments.

As far as our research on Guarulhos has developed, there are several initiatives on knowledge (and spatial knowledge) building, increasing use and exchange but not that much in contestation. Considering the potentials of knowledge building, use and exchange and contestation for building a strong governance culture towards sustainability and inclusiveness, there is a long way to go to fully take advantage of developments under way and embrace demands and challenges. Is worth to look at one areas that area of particular interest to our research: the Office of Participatory Budget.

Knowledge production and Participatory Budget in Guarulhos

The participatory budget was fully incorporated into the municipal agenda in 2001 with election of the first PT mayor. During the first three years of the new administration, the OP was conducted as an annual process, including between 7 to 8 thousand participants in neighborhood plenary sessions (8.279, in 2001; 7.183, in 2002; 7.516, in 2003). The political features of OP are examined in the next section, while here we look at the knowledge production for enhancing participation. After comprehensive evaluation conducted in 2004–the administration could not handle and even more effectively respond to the demands presented in the annual plenaries and ordinary citizens did not understand the way the municipal government was organized and how it worked – the administration decided to invest in an education project/building a knowledge culture and have plenary sessions every second year.

Recognizing that the municipality had limited experience and resources to implement such educational project, in 2005-6 an independent institute was hired to provide the needed expertise. A partnership between the municipality and the Instituto Paulo Freire (http://www.paulofreire.org/) was established. The major aim of this partnership was to develop a process for continuing education, in the broad sense, of delegates and counselors of the OP in Guarulhos. During the past 7-8 years, there has been a continuous effort in this direction and although educational processes need long-term investment and time to mature, results have been very encouraging. Trainings on specific issues of public and local administration (open bids, inspection, budget, fiscal control, setting priorities, project approval, etc) have been conducted. According to the OP office, participants report a better understanding of how local administration works and what are some of the complex steps involved in the decision-making processes and policy implementation.

Although the 23 OP zones are precisely defined and can be spatially identified, use and integration of spatial information into the daily routine and operations of the OP office is still marginal. As far we were able to assess, there is no GIS user/data producer as part of the OP office staff. Neither is there use of maps for conveying information. The information flow is pretty much restricted to means based on oral tradition (meetings and discussions) and written reports. This current status could be partially explained by the lack of a spatial culture by officials and the importance of oral language among social movements' leaders and less educated people, including illiterate individuals, which is the major audience related to the OP office. The Web is an important platform to inform about meeting schedules, particularly during the biannual cycle of plenary meetings in the 23 regions. It is not clear how much the web is actually used by local communities. The word of mouth remains a very important dissemination strategy among social movements.

The current scenario on use of spatial information is likely to change in the coming future. On the one hand, the OP office is being increasingly involved with more complex issues, demanding access to various sources of information and data integration. On the other, there is a consolidated understanding among the OP coordination and staff, that the great challenge and opportunity is based on sharing information. As an official stressed in an interview, "information has to reach people, because when this happens and we provide information with quality, the ordinary citizen builds understanding and even if she/he is still critical, the criticism is based on knowledge and not simple political preferences or empty of content as frequently seen and experienced."

Materiality – products, platforms, how knowledge travels (see above)

The trajectory of GIS in Brazil was informed in many ways by a larger movement for developing ICT-GIS systems for public policy that started in mid 1960s. During the military dictatorship (1964-1979), in 1967 the National Commission on Cartography (CONCAR) was created. Its mandate was to set the basic guidelines for Brazilian cartography. Interesting enough, the late 1960s were right before the Federal Government launched a very ambitious national development plan for the whole country framed within a military geopolitical platform and widely promoted. With democratization in Brazil, increasing importance of social movements nationally and globalization, new elements were incorporated into this process of data producing and management, including spatial information.

In 2010, the National Spatial Data Infrastructure (INDE) was officially launched by the federal government with the mandate of being "the integrated body of technologies; policies; mechanisms and procedures for coordinating and monitoring; standards and agreements necessary for facilitating and normalizing generation, storage, access, sharing, dissemination and use of federal, state and municipal geospatial data." (www.inde.gov.br). The Brazilian Geospatial Data Depository (DBDG) was implemented to integrate various public data sources and the portal "Sig Brasil" designed as a platform for providing access to data and data dissemination, following simple, fast, comprehensive and integrated procedures accessible to non-expert audiences. The Portal "SIG Brasil" is running

but initiatives are taking longer to be fully implemented. The key drivers of those initiatives have been to make public data available on the Internet and to make it easily accessible as instruments for public planning, general information and accountability. Most information on the Internet under these initiatives is not necessarily explicitly spatial or is provided in various nested spatial scales.

The Brazilian Institute for Geography and Statistics (IBGE, national census bureau) has acted as an important portal for disseminating a variety of socioeconomic and demographic data, as well as layers with territorial boundaries (census tract, district, municipality, state, major region and country) allowing for mapping and displaying in a GIS environment. DATASUS (www.datasus.gov.br), a comprehensive system integrating several subsystems for data on health at large for the whole country at various scales has significantly contributed to setting standards for data collection, data quality, data storage and data dissemination, which have positively other federal ministries and departments.

EMPLASA (www.emplasa.sp.gov.br), the Sao Paulo Metropolitan Planning Company, that is under the State Secretary for Metropolitan Development and has representatives at CONCAR, is an important depository for geospatial data in the state of Sao Paulo. Its data depository has been mainly used for EMPLASA's own work on the area known as the Paulista Macro Metropolis (MMP) including the four metropolitan regions in the state: 1) Sao Paulo, 2) Campinas, 3) Santista Coastal Zone and 4) Paraiba Valley and North Coast. Since approximately 2007-08, EMPLASA has launched some initiatives in regards to data sharing with municipalities in the Sao Paulo Metropolitan Region (SPMR).

For software development and platforms, as a general guideline Guarulhos has followed the federal orientation pushing for privileging free and/or open source software for general administrative purposes. However, there are exceptions and corporate software has been adopted in some areas due to performance, integration, security and cross-communication between platforms. For instance, servers at the datacenter at DIT run under the Oracle platform for managing databases and this also structures the whole CorporateGeo initiative mentioned above, while ARCGIS is the major GIS software in the GIS division. There is no survey on GIS software being used in the municipal administration in Guarulhos. As far as we were able to identify, municipal departments use a variety of GIS software. This has very much to due with personal preferences, adherence to "cultural" preferences of disciplines or fields and the decentralized process and timing for incorporating GIS into the working environment in Guarulhos.

Although this broader context and issues mentioned above have informed the ICT-GIS-based knowledge management in Guarulhos, initiatives and programs have very much been carried out independently by local government. This also relates to funding, as only a limited number of programs have been funded by federal resources. The municipal government has made a significant investment in increasing assess to information for ordinary and less educated citizens, which include making more user-friendly Web portals and interfaces as well as creating Internet public kiosks with free access to computers in low income neighborhoods. However, as far as we could assess, processes for producing spatial knowledge through citizen participation are seldom present. Our assessment is that the spatial information culture and mapping is still very much a codified discourse and practice that has not reached out or "positively contaminated" ordinary citizens.

At the municipality, the WebGeo portal (http://webgeo.guarulhos.sp.gov.br/webgeo/index.php) was launched in 2006 and since 2012 the CorporateGeo Platform (GeoCorporativo) is being developed. The CorporateGeo aims to provide corporate-based information and data covering administrative, socioeconomic, cultural and environmental issues. The basic goal is to create a secure data environment, minimize efforts and maximize results, improve data quality, provide added-value geospatial products (maps, indicators, metrics) and maintain an up-to-date data warehouse that is able to supply information for the increasing demands. Efficiency, transparency, participation, and inclusiveness are the corollaries informing this process.

5.1.4. Lima, Peru

Discourses and rationales for introducing ICT-GIS-based KM in urban governance

In general, governmental actors in Lima apply a dominant "pro-growth" and/or "pro-sector" policy discourse. There is a strong bias towards putting national visions ahead of metropolitan or local scale ones, especially in Lima metropolitan (LM) as Peru's capital city.

The degree of spatial knowledge penetration is relatively low. In general, organizations in charge of generating basic climatic, physical and socio-economic information useful for measuring city vulnerability, adaptation capacities and socio-economic trends, belong mostly to the national government and depend on different ministries. This hinders access and management of information since government institutions lack the ability to expand and

update information. Existing information is not accessible, too expensive or out-of-date.

Spatial information management systems in LM are partially developed; institutions have very low budgets and initiatives are fragmented. Private sector institutions that develop these instruments such as think tanks and consultants rarely share their information and sell it at very high prices. At the same time efforts are duplicated and the generated cartography cannot be matched due to the use of different geo-reference systems. Municipalities and ministries use these systems mainly for mapping purposes (services, street maps), taxation, delimitation of boundaries, zoning, determination of urban parameters and the development of big transport infrastructure projects, among others.

Spatial knowledge systems (in GIS) have the advantage of visualizing trends, impacts and territorial problems in an easier and faster way with high capacity for storing large amounts of data; and for calculating, organizing and relating statistical information within graphic media. ICT_GIS based systems are used in urban planning for visualizing changes on the supply of energy and water networks, the allocation of facilities, and modeling urban management systems for mobility or retail distribution purposes. For planners and project developers it is essential to territorialize problems as a complement to the texts they write and the statistical tables they produce. In that sense, a system that links cartography with databases is seen as useful for investors, officers and users, not only for planners.

For most district municipalities in LM the urban cadaster has a well-developed GIS system, which is updated and introduces precise measurements and geo-referenced allocation of plots. However, none of them are connected to each other. The quality of the geographic information generated is essential for users, facilitating decision-making for investors, particularly where it is available via internet as it is the case in the high-income districts of Miraflores, Surco, San Isidro and La Molina as well as Callao Municipality. Having a web-based cadaster is considered to boost productivity, which implies that GIS instruments are linked to competitiveness discourses aligned with modernity and cultural patterns of global cities and globalization in general which have a great deal of influence on important sectors of LM and Peru.

The use of GIS technologies is widespread in the business sector –such as real estate–, state sectors with higher levels of modernization –such as transport, basic service providers, high income municipalities–, and academic and professional sectors linked to globalization processes and large-scale infrastructure development. One of the sectors that has more affinity with this new culture is the Ministry of Housing, Construction and Sanitation (MVCS) that understands its role as supporting the private sector, generating information for facilitating real estate investments. According to the national director of urbanism from the Ministry, "today the private investor has the macro-vision of the city and the state works as a supporting entity (and) geographic information provides tools for helping investors to confront zoning plans with infrastructure deficits". This statement shows the position of an important government Ministry about the private sector as the main developer of Metropolitan Lima and how it should be using spatial knowledge provided by the Peruvian State.

Knowledge management in urban planning in the city: actors and networks

Both (international) public and private sector actors participate in the management of spatial knowledge in LM. The national level of government includes ministries and its main agencies; the regional level includes the Regional Government of Lima, the Regional Government of Callao (GRC) and 'Lima Provincias'; the metropolitan level includes the MML, the municipality of Callao and the municipality of Huarochiri; and the local level that includes 49 districts (43 districts in the Lima province and 6 in Callao). They present a spatial knowledge institutional system in LM shown in table 5.1.13. Development visions are mostly channeled through sector/centralist-based policy actions with a rather fragmented approach to territories (often through the direct intervention of ministries or the president himself). This has important knowledge management connotations, since generally sectoral approaches remain independent and do not integrate information into common formats or platforms.

Public and private actors and networks involved in activities related to knowledge management for urban planning in LM can be divided in two functional groups: those ones who collect and generate basic information and those ones who analyze, integrate and translate gathered data. Among the former we can mention national government institutions and some private firms, while among the latter we can mention municipalities, universities and some civil society institutions (see table 5.1.14).

One of the national government institutions that produce basic information for urban planning in LM is the National Institute of Informatics and Statistics (INEI) that carries out population and housing censuses, and studies such as the National Household Survey (ENAHO), the Permanent Employment Survey and the household

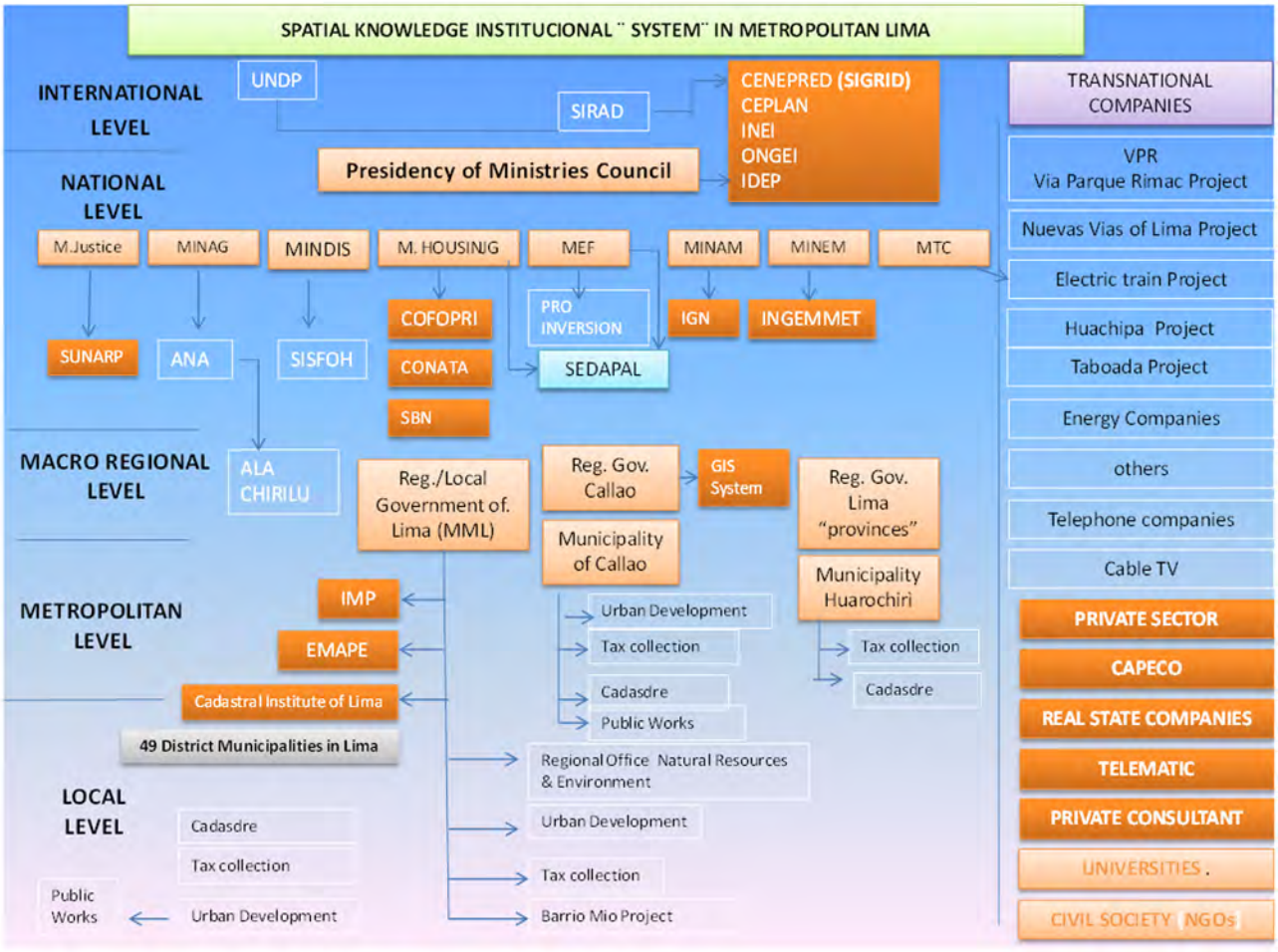
screening system SISFOH that has a socio-economic information system of poor and vulnerable households called the General Household List ('Padron General de Hogares') for identifying and selecting potential beneficiaries of social programs. It relies on cartography for locating houses and households.

Other institutions that produce socio-economic information are opinion and market studies such as Ipsos-Apoyo[42] and the 'Cuanto' Institute.

In relation to the production of information regarding urban and developable land the following public institutions coexist: the Superintendent's Office of National Assets SBN that administers public plots and other state-owned estates, the National Valuation Council CONATA that determines urban land values, the Superintendent's Office of Public Registries SUNARP in charge of organizing real estate registration, the Agency for the Formalization of Informal Property COFOPRI in charge of formalizing land property and generating a cadaster with formalized plots; and the Metropolitan Planning Institute IMP at the metropolitan level. IMP and the Office for Territorial Conditioning of the Callao Regional Government GRC work together in making compatible zoning maps regarding hydrographic basins. Despite the lack of connections between Lima and Callao, the relationship between the IMP and Callao is very strong, being supported by the fact that the IMP has developed several planning instruments for Callao.

42 IPSOS-Apoyo is a market research firm that integrates the IPSOS French multinational and the 'Apoyo Opinión y Mercado' local firm.

Table 5.1.13: Spatial knowledge institutional "system" in LM.



Elaborated by Liliana Miranda and Isabel Fernandez, 2013

National government Institutions and some private Institutions which produce a geographic information system very useful for urban planning

Municipalities, universities and some private institutions of the civic society, who interpret, analyze and integrate that information

In relation to urban cadasters, the MML works with the Cadaster Institute of Lima, but that only works within the 'Cercado' central district. Each district municipality makes its own cadaster, and their quality is very unequal.[43] The absence of an integrated system of cadaster information across LM constitutes a barrier for an integrated understanding of its territory, since the cadaster is mainly used as a tool for property taxation and not as a territorial management and development instrument, neglecting the possibilities of spatializing the allocation of government activities according to local needs.

The Ministry of Housing integrates cadaster databases (developed by district municipalities) with official land valuations. After signing an agreement municipalities can buy land value information based on their own cadaster maps for taxation purposes. Their idea is to eventually expand the use of cadaster now used purely as a taxation instrument to become an instrument of territorial management and development. Indeed municipalities have to use 2% of total taxation revenues for cadaster and planning issues but they do not, especially considering the very low existing levels of taxation and the very high operating costs.

In relation to housing, the Ministry of Housing, Sanitation and Construction is the main actor (it contains the CONATA and the MIVIVIENDA fund). The National Directorate of Urbanism from the same ministry formulates national urban regulations but also elaborates urban plans and provides technical assistance to provincial municipalities. In the private sector, the Construction Chamber CAPECO brings together construction enterprises in the country and produces information related to building prices, and carries out market studies.

In relation to informal settlements, processes of formalization are held by the Commission for the Formalization of Informal Property COFOPRI that is also in charge of elaborating plot and perimeter plans, and public registration of properties. These plans are elaborated using maps and GIS systems, and the configuration of a district level graphic base of urban properties and cadaster. The

43 Districts with updated cadasters are Miraflores, Surco, San Isidro and San Borja. Biggest lacks can be found in peripheral districts that count with less resources and where land traffickers promote land occupations (cadaster cannot perform as a control instrument against land traffic). Districts such as San Juan de Lurigancho have incomplete cadasters that only cover consolidated areas. In San Juan de Miraflores, cadaster is more related to taxation.

Table 5.1.13a: List of actors.

Institution	Definition	Institution	Definition
UNDP	United Nations Development Programme	**M Justice**	Ministry of Justice
SIRAD	Information System of Resources for Disaster Attention	**MINAG**	Ministry of Agriculture
CENEPRED	National Centre for Prevention, Estimation, and disaster risk reduction	**MINDIS**	Ministry of Defense
CEPLAN	National Strategic Planning Center	**M HOUSING**	Ministry of Housing
INEI	National Institute of Information and Statistics	**MINAM**	Ministry of Environment
ONGEI	National Office of electronic government and information technology	**MINEM**	Ministry of Energy and Mine
IDEP	Infraestructura de Datos Espaciales	**MTC**	Ministry of Transport and Communications
ANA	National Authority of Water	**MEF**	Ministry of Economy and Finance
ALA	Local Authority of Water	**ALA CHIRILU**	Local Authority of Water of Chillon, Rimac and Lurin rivers
MML	Metropolitan Municipality of Lima		

Elaborated by Liliana Miranda and Isabel Fernandez, 2013

procedure implies the construction of a cartographic mosaic named 'territorial unity' that is incorporated to the graphic and statistical base of COFOPRI.

In relation to environmental issues, the Ministry of Environment is the key actor. It formulates environmental norms and policies, and provides assistance for elaborating ecological-economic zoning. Other important bodies are the Sanitation Deputy Ministry (MVCS) and the water company SEDAPAL that has one of the most detailed and up-to-data base maps of the city. Within the MML, the Deputy Regional Office of National Resources and Environment deals with protected areas, basins and water-hydrological resources. It has generated the first ecological structure map in LM and the first map of public spaces and green areas of Lima.[44]

In addition there are more specialized initiatives, such as the Ministry of Environment Geoserver[45] that processes information related to environmental issues using official data provided by various government departments. So far such data has not been standardized and cannot be matched to a base map.

It is important to mention the efforts from the Ministry of Housing for generating a climate map of Peru, which is accessible via internet in order to permit project developers to apply bioclimatic design in the whole country.

In relation to vulnerability issues, the National Institute of Civil Defense INDECI formulates and supervises the National Plan for the Management of Disaster Risks and leads the SINAGRED system for executing the plan. Additionally, the National Center for the Prevention and and Diminishing of Disaster Risk CENEPRED is in charge

44 In: http://www.munlima.gob.pe/limaambiental/component/k2/item/72-estructura-ecologica

45 See: http://geoservidor.minam.gob.pe/intro

Table 5.1.14: Public agencies involved in spatial knowledge management for urban planning in LM.

INSTITUTIONS	Agencies	Role Description
CENEPRED	SISGRID	Information System for disaster risk management: for Lima SIRAD
Ministry of Justice	SUNARP	National Public Records Superintendence
Ministry of Housing	COFOPRI	Formalization of land property agency
	CONATA	National Council of real estate value appraisals (for defining the municipal taxes)
	SBN	National Superintendence of real estate property (state assets)
	SEDAPAL	Water Company for Lima and Callao
Ministry of Defense	SISFOSH	Poverty mapping for social programs focalization
MINAM	IGN	Geographic cartography Institute
MINEM	INGEMMET	Geology mapping, mining and concessions Institution
MEF	PROINVERSION	Megaprojects mapping
Regional Government of Callao	GIS Territorial System	Mapping of boundaries, human settlements, Ecological and economic zoning
Metropolitan Municipality of Lima	ICL Cadastral Institute of Lima	Lima "cercado" cadaster, mapping for MML offices by request (as consultant)
	IMP	Metropolitan Institution of Planning
	EMAPE	Municipality Company of Toll Administration
District Municipalities	Cadaster offices	Locating, sizing and defining owners of the real state in the district plot by plot

Source: Self-developed

of coordinating, facilitating and supervising the formulation and implementation of the Disaster Risk National Plan and the Information System for Disaster Risk Management SIGRID. Also the Geo-Physical Institute studies natural phenomena that can affect the national territory, and the INGENEMET has developed a study of critical areas in danger of landslides, flooding and mudslide disasters in LM. The UNDP has elaborated the Information System of Resources for Disaster Attention SIRAD, a GIS-based web mapping service platform that links digital maps with databases on decision and intervention centers, water supply, food supply, emergency medical attention, energy supply, transport, telecommunications, potential areas for shelters, potential areas for gathering rubble and economic areas. It permits local and regional authorities to analyze the vulnerability of essential resource inventories for organizing and monitoring post-disaster recovery processes (for the case of Metropolitan Lima it is very focused on earthquakes and tsunamis, and not on climate change issues). It is based on a model developed for Quito, Ecuador. The platform has been installed in the cities of Lima-Callao, Cañete, Huaura and Trujillo.

The National Directorate of Territorial Demarcation of the Prime Minister's Office PCM is the technical entity in charge of providing information for decision-making on boundary demarcation, and local institutions such as the IMP work together with it. Then, boundary demarcation decisions pass through the "Territorial Demarcation Commission" of the National Congress, which tends to politicize the process, and at the end decisions are taken based on how many people protest or lobby the congress. The National Geographic Institute IGN is a decentralized public agency (in the defense sector) that aims to elaborate and update basic cartography in Peru, participating on the creation, delimitation and demarcation of territorial demarcation by providing official cartography.

In implementing large-scale urban projects, there are many municipal agencies such as the Metropolitan Office for Private Investments Promotion GPIP[46] that has promoted projects such as 'Via Parque Rimac', 'Nuevas Vías de Lima' and 'Via Expresa Sur', which uses instruments such as data room, synthesis plans, and infographies. There is also the Toll Administration Company of Lima EMAPE, that builds and administers highways and other high transit roads; and the Metropolitan Fund of Investments INVERMET that finances and executes projects and infrastructure works in the city. Both agencies –together with the Urban Development Office and the Neighborhood Participation Office of the MML– form part of the directors' board of the 'Barrio Mio' program.

Network Formation

The Metropolitan Assembly AML is a consultation and coordination body of the MML integrating 42 district mayors from Lima and 29 representatives from civil society. The mayor of Lima presides over the assembly and coordinates efficient implementation of metropolitan plans[47]. The civil society group within the AML has been very active during the current Administration and has approved the Concerted Regional Development Plan (PRDC) and often requested information about its execution. They have insisted on the role of the IMP in the plan's enforcement and on making it decentralized and participatory in nature. The PRDC and the Regional Disasters Plan use spatial information, together with some topics raised by the AML such as implementing electronic consultations for participatory budgeting processes.[48]

The Regional Conference for Social Development of Lima COREDES[49] brings together a number of CBOs and CSOs. In 2010 it elaborated an agenda for Lima in the context of the municipal electoral campaign that year. The agenda contains different aspects of the city including economic and urban development.[50] Information related to the agenda was submitted to the new administration and a number of mixed work commissions (MML and COREDES) were convened to contribute to the Operative Institutional Plan of the MML. Several members of COREDES have been elected members of the AML.

The Poverty Fighting *Concertacion* Group MCLCP ('Mesa de Concertación de Lucha contra la Pobreza')–

46 Local equivalent to the PROINVERSION national agency.

47 Such as the Concerted Regional Development Plan PRDC and the Urban Development Plan.

48 The same assembly previously worked on a political document called 'El Acuerdo por Lima' (Agreement for Lima) that was presented by the mayor in 2011.

49 COREDES belongs to the National Conference for Social Development (CONADES) that is a national scale meeting space of networks, organizations and citizen movements in the country.

50 The agenda was composed by a series of programmatic proposals that Lima's civil society (concentrated in COREDES) proposed to the candidates for metropolitan mayor. It included topics such as urban management; soil, housing; habitat and vulnerability; economic development and employment; capacity building; security; environmental management and climate change; fight against corruption and culture.

Work group on housing was created as *concertacion* space by Supreme Decree 01-2001-PROMUDEH in 2001. The MCLCP of LM[51] consists of a working group on housing where representatives from the MML, district municipalities, national government agencies such as COFOPRI and INDECI and several NGOs participate actively. They are discussing intervention strategies of the Metropolitan Popular Housing Program of the MML and the 'Kuelap' project in the 'El Agustino' district, the first pilot program of low-income urbanization on hillsides. The Popular Housing Program presented to the MCLCP geo-referenced data for identifying possible plots for urban renewal, estates in ruins, monument estates, land uses and quantitative housing deficits (block level). That space also has a working group on water and environment, among others.

The environmental sector is one of the most advanced in spatial knowledge management. In relation to hydro-climatic knowledge management there are programs and projects from:

- national entities promoted by the Ministry of Environment MINAM and the Lima Metropolitan Municipality MML (Office of Services to the City / Environment Deputy Office GSC/SMA) and the Office for Parks Administration SERPAR;
- the Provincial Municipality of Callao MPC and the Lima and Callao regional governments;[52]
- district municipalities (e.g. the climate pact between San Borja, Pueblo Libre and Miraflores, signed in September 2012);
- research projects by the 'Servicio Nacional de Meterología e hidrología del Perú' SENAMHI, 'Instituto del mar del Perú 'IMARPE,[53] Chance2Sustain, LiWa (with the participation of SEDAPAL, MML, the NGO Fomento de la Vida FOVIDA, National Engineering University UNI, FORO, among others)[54] and several universities ('Pontificia Universidad Católica del Péru PUCP among the most renowned);
- technical cooperation projects by UNDP and AVINA;[55] and from CSOs such as The Cities for Life Forum and the 'Movimiento Ciudadano Frente al Cambio Climático' MOCCIC, among others.
- a multi-sectoral team convened by civil society and governmental representatives that developed the Environmental Atlas of Lima[56] (initiated in 2002 and published in 2009).

Another initiative for spatial information management is the Liwa Tool, a computerized model for water flow under development by IFAK as a member of the German-Peruvian team of research institutes working under the Liwa research project.[57] One of the most important contributions of this study was the standardization of thematic information, which enabled data comparison (see Miranda Sara and Baud 2014).

Knowledge building, exchange, contestation and use

Processes of construction, exchange, contestation and use of spatial knowledge are influenced by contradictory trends. On one hand, there is the introduction of new information technologies in the context of globalization. The introduction of ICT-GIS systems in urban governance belongs to a technological revolution experienced by the whole world, with the global economy relying increasingly on telecommunication and information.[58]

Public entities have Internet-based consultation systems such as COFOPRI that has a free on-line service that permits users to check the situation of their plots and their records. Another important system is the online cadaster with information about land status for developing urban and rural development plans, transport, environment, security, and taxation. Access via internet is free or preferential for public and private sector actors as well as the general

51 As a concertation space, it does not count with specific members, but participants that represent a series of public institutions and social organizations that exchange information and sometimes reach some level of agreement.

52 The Regional Strategy of Climate Change of Callao has been approved and its second update is in progress.

53 See: http://www.imarpe.pe

54 A computerized water flow model system http://www.lima-water.de/

55 Latin American foundation supported by the VIVA trust fund created by Stephan Schmidheiny for promoting sustainable development through an alliance between private companies and philanthropic organizations.

56 http://www.geoserver.itc.nl/lima/start/start.html

57 In: http://www.lima-water.de/

58 Another group making extensive use new communication technologies is the new generation of youngsters from all social levels, as evidenced from the large numbers of internet cafes in the country and particularly in LM. Nonetheless, greatest part of this interest is related to amusement and to a much lesser extent to more academic purposes. Thus, there is a pending task to take advantage of that interest for new technologies, but relating it to greater social challenges.

public. SUNARP has a web-based information system of registered estates named Virtual Registry Tutor, and the SBN has an integrated system of geographic information and numeric databases that enhances the management of cadaster information and more efficient administration.

On the other hand, there is a persistent 'secretism culture' related to low levels of transparency and sharing, especially by government representatives and consultants. There are cases when information is hidden for securing real estate investments in hazardous areas (i.e. the 'Costa Verde' which is a high risk area because of earthquakes and tsunamis); and opposite cases when information on hazards is intentionally used to undervalue land for securing investments through cheaper reallocations and expropriations, like the LA-VPR case.[59] There is also the fear that information might empower new actors against existing local leadership, undermining existing investment dynamics secured by agreements between private operators, social leaders and local government. For instance, during the LiWa tool construction process, SEDAPAL limited access to their information to the IMP and other institutions, despite signing specific agreements for doing so earlier. This can be related to a lack of trust about possible further use of the information by the IMP, a divide between water and land policies, and the referred secretism culture.

Lack of trust in sharing information is the fundamental problem facing the buildup of a multi-sector platform for information exchange and knowledge construction, One reason for this concerns the cost of information and lack of institutional continuity: from high levels of rotation of public officers to land trafficking mayors and powerful economic groups that prefer to keep information well hidden. Each election in LM represents a complete change in the composition of the high level technical and political team for each Municipal and/or Regional Government and/or National Government if representatives are not reelected. This implies a complete absence of continuity or means of knowledge accumulation in the public sector. City officers do not have expertise for daily use of geographic information; and when managers' capacities are developed, they leave the institutions (sometimes taking all the information with them) because of the rotation in government.

In contrast, civil society institutions tend to function as a kind of repository of databases and experiences, and new administrations often go there after elections to request information about their districts. Interestingly, members from the local community claim their right to include upcoming authorities into the process; recognizing and legitimizing their presence and openness to transfer knowledge. In general social leaders have a very strong tacit knowledge on how to deal with public agents in political spaces while technical institutions (such as DESCO and CENCA) provide technical and financial information for supporting their discourses.

Knowledge Construction in Urban Planning

In the construction of urban and spatial planning several actors participate by developing local, regional, national and (international) regional integration megaprojects (such as IIRSA among others) as table 5.1.15 shows. Nevertheless, the different levels of planning remain rather independent. There remains a strong disconnection between municipal and regional bodies and service providers when defining land use and implementing infrastructure, with a constant interference of judiciary courts. LM lacks territorial planning with well-articulated technical spaces in coordination with national level.

There is neither an integral nor unitary vision of the city as a whole. The dominant rationale has not given any priority to long-term planning, but has consolidated market orientations through several deregulation policies (through administrative simplification), weakening regional and local institutionality (even as a part of the decentralization process), and relying on megaprojects as drivers for city development engines that have exacerbated conflicts and generated corruption problems.

Large real estate operators and private investors (supported by lobbyists and consultants) hold the clearest 'pro-growth' vision on LM with no counterdiscourses from social organizations that remain very fragmented and focus on immediate house and neighborhood scales. Private sector operators (VEOLIA French infrastructure and environmental services provision firm), has prepared a vision on re-developing new centralities, along the 'Costa Verde' and South Lima sea-fronts and a whole new 'self-sustainable' city of almost 35000 ha on the southern part of the city. The official vision to year 2025 published almost 3 years after the URVIA-VEOLIA vision legitimizes this by referring to poly-centrality[60] and proposing 'coastal

59 In 2007 the MML passed the City Ordinance 1020 that appointed the MIRR (direct social impact area of the LA-VPR project) as a *special regulation area* and that reallocation due to risk reasons was of public necessity for safeguarding security. Declaring the area as a risk zone would dramatically devalue properties and legitimate forced evictions.

60 "The traditionally monocentric structure of Lima has started to disappear with the creation of the first deconcetrated development poles, largely driven by real estate laws before the guidelines of an always incompetent and inefficient urban planning" (Ludeña 2010:76).

border' developments on the 'Costa Verde' and Southern Lima and a 'self-sustainable' expansion in the same southern quadrant of the city. Despite the celebrated participatory and 'concertative' nature of the plan, the referred map (figure 5.1.16) was not developed through participatory processes and no technical information is provided in relation to both megaprojects. Although the PDRC relies on reorganizing the existing core of the city, it is also pushing for the development of massive quantities of new urban land for an already sprawling city, with unknown future effects on the Lurin Valley. This means that the southern area of Lima will be the last battlefield between the last farmers and speculators' voracity. Today the desert invaders are not homeless poor migrants. New invaders are the new rich and big real estate consortia whose growing power has been consolidated by reducing a huge eco-park in the South of Lima from more than 8000 ha to 1700 ha (Ludeña 2010:47).

The current planning vacuum becomes a very complex issue, especially when the biggest construction firm in Peru is planning to develop a satellite city bigger than 8 km^2 in the referred area with no apparent attention to self-sustainibility.[61] Developing strategic guidelines with no further technical backup or social support, such as the PRDC on the south of Lima risks permitting –instead of regulating– market-led unregulated initiatives (Figure 5.1.17).

Territorial Planning in LM (OT)

The IMP is currently elaborating the territorial plan, including not only the urban areas of Metropolitan Lima but also its four river basins. The plan for the Chillon and Lurin basins is currently under development (2012), and

61 In: http://gestion.pe/inmobiliaria/grana-y-montero-desarrollara-ciudad-satelite-al-sur-lima-2060530

Table 5.1.15: Who does what in spatial planning in Peru?

	(INTERNATIONAL) NATIONAL	(MACRO) REGIONAL	LOCAL LEVEL	
			PROVINCE LEVEL	DISTRICT LEVEL
MACRO INTERNATIONAL PROJECTS (IRSA: transoceanic etc.)	X	X		
CONCERTED DEVELOPMENT PLANS	X	X	X	X
NATIONAL TERRITORIAL DEVELOPMENT PLAN 2004-2013	X			
NATIONAL PLAN OF URBAN DEVELOPMENT (MVCS)	X[62]			
TERRITORIAL DEVELOPMENT PLANS (Macro, middle and micro ZEE, EAE)	X	X	X	
LAND MANAGEMENT PLANS (Watershed programmed, brokers, intermediate cities…)			X	
URBAN DEVELOPMENT PLAN (Zoning Scheme, Risk Management Plan, PIGARS, Road and Transports plans, etc.)			X	X
RURAL DEVELOPMENT PLAN				X
HUMAN SETTLEMENTS DEVELOPMENT PLANS				X

Source: G. Takano and L. Miranda Sara

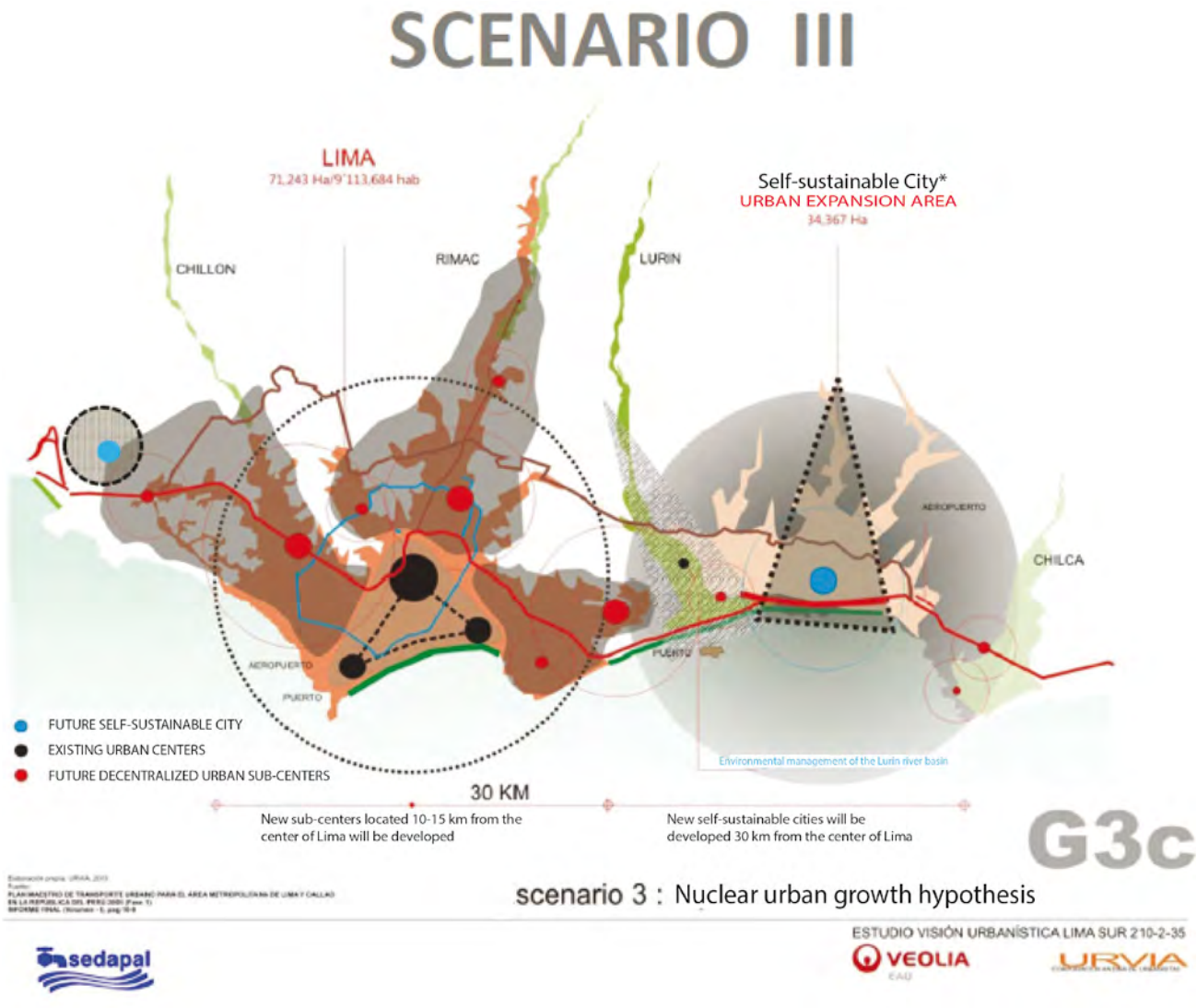
62 Only one National Urban Development Plan was done by the MVCS decades ago but it has never updated.

several workshops have been held with all district municipalities from these areas to prepare the proposal, with a second series of workshops planned after the conclusion of the plan to validate it (2013).

Such planning processes are supposed to go beyond economic-economic zoning (that remains a diagnosis), implying a level of collaboration (through agreements) with LM's neighboring provinces. Indeed the IMP is working with the territorial conditioning office of the Callao Regional Government (GRC) to standardize the already developed zoning in Callao with planning at the river basin level. However, when formulating the Territorial Planning Plan certain information problems arose in relation to environmental management. These include:

- physical geographical mapping was done for the first time only a few years ago and the hydrogeological map is 30 years old with no updates.
- The National Authority of Water has no studies about groundwater supply in Lima (despite the fact that it is the most important urban water source). The IMP has to go to that authority to get information about water quality, which it has only for very specific areas of the city.
- The Civil Defense Institute has no geographic information about hazards and vulnerabilities. There are several versions of the hazards map, but none has been formally approved by INDECI, the MML or the MPC.

Figure 5.1.16: LM's future vision from the private sector to year 2035



Source: Florez, R. 'UNA VISIÓN DE LIMA AL 2035' Presentation at the "PLANIFICACIÓN DE LAS CIUDADES, TRANSPORTE Y CAMBIO CLIMÁTICO" seminar. November 2010.

After the approval of the Ordenamiento Territorial OT proposal a platform that aims to standardize the use and sharing of spatial information would start operating (to be developed as a project of the new PRDC). For the Rimac and Chillon basin areas in Lima and Callao, an agreement between INEI (National Institute of Statistics) and water company SEDAPAL has been signed to establish a common cartographic base. The main strategy is to establish a nucleus that would progressively expand to a management information system and promote the use of metadata throughout the public sector in Lima. Currently, agreements exist only with respect to cartographic standards and do not yet provide an integrated system. Nonetheless, because common metadata is used there is transparency about who has created the information and what it represents.

An important issue is that these kinds of activities depend more on politics than technical decisions; and current relations between offices reflect specific interests instead of institutionalizing information platforms. For

Figure 5.1.17: 'Lima Policentric City'. MML-PRDC's visión on LM to year 2025



Source: MML (2012)

example while the IMP is currently coordinating with SEDAPAL; the mayor of Lima is claiming a chair on SEDAPAL's board with a clear denial from the central government. Also, when the national government realized that transferring territorial planning OT functions to the MML would have an important empowerment effect regarding land policy decision-making, it decided to stop the transfer process from Environmental Ministry to MML.

A different kind of initiative comes from the Plan of Incentives for Municipal Management (Law 29332-2011) by the national government. According to this policy, an economic incentive of 1 million PEN was offered to each municipality that would identify physical risks in their jurisdictions. 1200 out of 1800 municipalities responded to the plan during 2012. For those 1200 municipalities, an extra 1.5M were offered for translating that information into mitigation plans and 700 responded which is considered a great success by the Ministry of Housing. Even though the response from local governments has been massive, no appropriate guidelines about the required information have been designed (no indicators, variables and not even definitions of danger or vulnerability) and the quality of the information given back to the national government is very mixed. Also, the provided incentives can be used in discretionary ways and not for dealing specifically with risk and vulnerability issues.

Spatial knowledge produced through citizen participation processes

Knowledge components of the 'Barrio Mio' program for upgrading sub-standard settlements

At the metropolitan level, "pro-poor" and "pro-life" focuses have recently started to become more relevant within the new administration. These approaches are materializing in ongoing large-scale programs such as 'Barrio Mio' that aims to build urban infrastructure in marginal areas. The first step of the project is to reduce physical vulnerability by building stairways and retaining walls. After the first phase, several integral urban projects will be executed by using participatory planning techniques, such as the construction of roads, parks, and sport infrastructure in accordance to the population's needs.

For developing its intervention model, Barrio Mio has developed an urban poverty map (based on the 2007 census) and systematic fieldwork gathering geographical data from dwellings established after the census. It has characterized the poorest populations according to their unsatisfied basic needs, and applied the GINI inequality index. 17 territories with relatively independent urban structures (a more or less defined core for programmatic purposes) were identified in peripheral areas of the city (most vulnerable). These areas were identified after analyzing demographic (INEI) and physical/geographical variables of the city. The aim was to build a model for prioritizing actions on a technical basis. The model would avoid political manipulation of investment prioritization; and 'anticipate the demand from the city', so that higher levels of organization/reaction capacities would not overpower real urban problems, and lead to biased decision-making processes.

For instance, when information on stairways was incorporated into the model, including the slope threshold for deciding where to build a stairway, the slope variable was correlated with a variable of existing stairs previously made by the community. This indicated the slope threshold assigned by the people and became the official one. The correlation indicated that those settlements with slopes steeper than 30% would necessarily need a stairway and those settlements with slopes between 24% and 30% would be on a transition stage (decisions on intervening in this range would be considered second priority and linked to other variables). The current identified limit for building on slope areas is 47%.

2012-2025 Concerted[63] Plan for Lima Regional Development as learning process (PRDC)

The new Metropolitan Administration considers it necessary to reactivate planning processes, by jumpstarting the new Concerted Development Plan 2012-2025 (PRDC)[64]. The plan proposes development guidelines for the city and will be the basis for more specific planning schemes, merging two different kinds of assessments: a first academic one made by consultants and technicians; and a second one made in a participatory manner. On this basis, the technical team integrates the knowledge produced and generates the final plan. Nonetheless geographic tools were not used systematically beyond specific topics such as transport, security and urban development (e.g. public spaces, urban equipment).

As methodology, the PRDC tried to identify certain

63 The term 'concerted' is related to the fact that the plan is approved by different local actors participating in its formulation.

64 According to the national legislation, concerted development plans are focused on the populations and propose general guidelines, while urban development plans are focused on the city and imply more specific projects and instruments.

Figure 5.1.18: Operative areas of the Regional Concerted Plan of Lima



Source: IMP/MML

areas of the city with relatively similar features for the analysis: Central Lima, South Lima, East Lima and North Lima and Callao (see Figure 5.1.18). After this subdivision the population from these areas was convoked through the citizen participation office of each municipality and the mass media. Then, two parallel participatory processes and their convergence were designed in order to merge sector and territorial dynamics. First, participants from different sectors (private sector, sub-national and national government, CSOs, universities and NGOs, the Church, territorial leaders, citizens) were convened to discuss a proposal about the vision of each 5 sectors. Second, a number of thematic meetings (sector-oriented such as education, transport, health, security) were convened in order to recognize specific issues in their areas. Despite the big efforts to open dialogue in the widest way possible, two fundamental actors for the future configuration of the city such as real estate operators and land speculators did not participate in the plan's formulation process.[65] The first group generally uses more direct mechanisms for expressing its points of view, and the second group remains marginal to regular processes due to its illegal nature.

There are several networks that bring actors together linked to several topics within city planning. Unfortunately the process of formulation and follow up of the Development Plan of LM (PRDC) does not have an institutionalized space that groups different actors. From that perspective, the neighborhood consultation system for 2013 MML participatory budgeting is an important achievement. The implementation of the system consisted not only of internet access, but also the installation of computer stations in public spaces such as parks, shopping areas, municipalities, the implementation of capacity building workshops, and the participation of public figures.

Other community-based knowledge building

Despite these efforts, the citizen participation processes in LM have not been focused very specifically on building spatial knowledge (neither in the process of construction of the PRDC or the electronic consultation mechanisms referred to earlier). However, there are very relevant local initiatives regarding the construction of community maps for risk management. These maps not only contain information about risks, but constitute an instrument for stimulating the population to reduce such risks.

Another aspect related to citizen participation and the follow-up of urban transformations and the performance of public institutions occurs around several ICT-based observatories such as 'Lima como Vamos'[66] that follows quality of life variations in LM. It is promoted by private sector institutions such as the Catholic University of Peru, Radio Programas del Peru (broadcasting), the 'Asociacion Civil Transparencia' (third sector) the German International Cooperation Agency GIZ and the 'Asociación Atocongo' (CSR). NGOs such as the Urban Observatory DESCO[67] and 'Info Vivienda' from CENCA[68] also have initiatives.

Community-based knowledge is used in reactions to large-scale projects, and the case of the MIRR facing LA-VPR is emblematic. For residents from the MIRR, the fact that they have never been consulted or properly informed, is a violation of their citizen rights, which made them contest the project by using the following knowledge-based negotiation mechanisms:

- Surveys: neighborhood associations surveyed the settlement as a tool for generating independent and community driven information
- Writing letters to the municipality to demand information
- Neighborhood councils organized informative workshops and assemblies where residents voice their concerns.
- Distribution of leaflets and newspapers written by residents/ leaders/ lawyers
- Shift from protest/confrontational phase to a conversation/legal phase: community protests give way to technical legal discussions,[69] establishing relationships with lawyers who offered legal expertise for challenging the contract

65 Considering that they do not take part of any similar process.

66 'Lima Como Vamos' –together with institutions from Arequipa and Trujillo– form part of a network of 70 similar institutions from different Latin American cities the Latin American Network for Just, Democratic and Sustainable Cities and Territories. These initiatives aim to improve city management with an inclusive, sustainable and ethical perspective.

67 The Urban Observatory DESCO is a web based virtual platform that contains information on public space and risk management (vulnerability maps for risk mitigation plans) for the districts of South Lima.

68 'Info Vivienda' summarizes news about housing, water and sanitation and urban development topics. It is used for following up the current urban situation and discussing it with the population where CENCA works (San Juan de Lurigancho district).

69 Importantly, this change of space has a negative effect: neighborhoods have atomized and tend to technically negotiate in parallel.

- Price calculations of their houses (independently of the evaluations made by the MML and the company)
- Fighting "Ordenanza 1020" at the constitutional court in a alliance with opposition congressmen.

At the Huascarán neighborhood (Right Margin of the Rimac River), the majority of the population completely rejects project implementation as the settlement is consolidated and not exposed to environmental or physical risks. The residents demand the construction of an alternative route, as there is ample space between the river and the first line of houses, making their own proposal for an alternative route for the highway.

Materialities

From the spatial knowledge point of view, the public institutions contribute by providing spatial registration instruments and virtual communication systems with users. However, the various systems in place are not always interconnected; they use their own cartographic bases; they do not share the same plot or coordinated systems of cadastral codes; their plot information does not coincide; and they do not show much interest in constituting a coordinated GIS and/nor cadastral system for LM.

An initial step in this regard is the Spatial Data Infrastructure of Peru IDEP that aims to integrate different public institutions that provide spatial information. It is still under construction but moving very slowly because it concerns a complex process of standardization. Its goal is to standardize and systematize cartographic and geo-spatial information from different state actors within a single platform managed by the National Government from the Prime Minister's Office (PCM). It is related to an important move towards electronic government well established at the Latin American level, with institutions such as the National Geographic Institute (IGN), the Navy, INDECOPI (in charge of standardization) and COFOPRI Participating in it.

In the development of the regional development Plan for Lima, community knowledge is being mobilized through consultations, and through the establishment of physical infrastructure using ICT which citizens can use in public spaces on a continuous basis.

Conclusions on Lima Metropolitana

LM is divided into two jurisdictions that at the same time are divided into one provincial municipality with regional government competences in Lima, both regional and provincial governments in Callao and 49 district municipalities. This fragmentation and absence of integrated and interconnected information systems constitute a serious barrier for developing integrated spatial planning and management at the metropolitan level. Authorities and officers are concentrated in their very own small territories, losing the metropolitan perspective and comprehension of problems affecting the whole city.

Although the production of sector-based knowledge belongs to national government institutions (that indeed concentrates the highest investment capacities in the city),

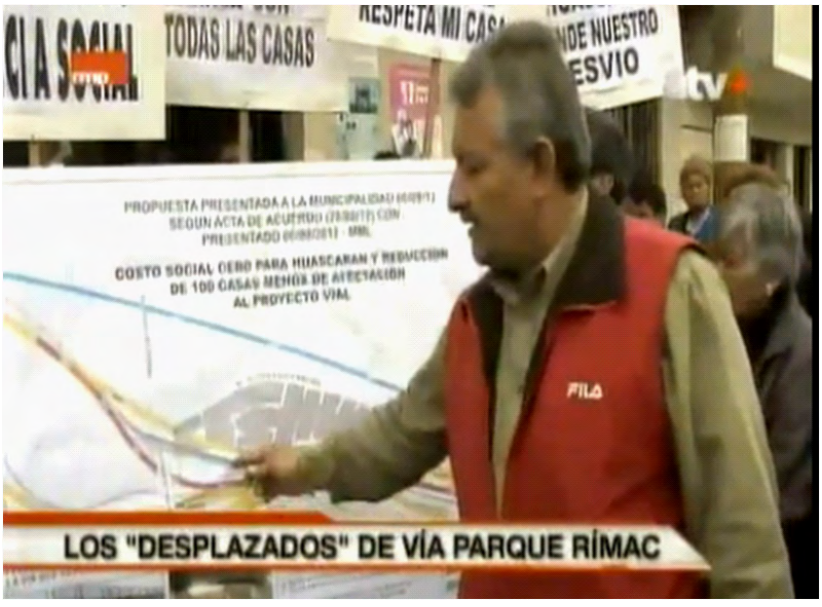


Figure 5.1.19: Social Leader from the 'Huascarán' neighborhood showing their proposal for changing the layout on TV

Still capture from 'RMP program from 21/11/12

Source: http://play.tuteve.tv/videogaleria/listado/111614/2012-11-22-21112012

local actors have to integrate knowledge through a more territorial view, incorporating it into an urban planning approach. Nonetheless, the lack of an articulated geographic information database undermines the possibility to reach an integral view of the metropolitan territory, and the dominance of centralized and sector-specific management from the national government fragments the city's future development.

This is evidenced by the small willingness to share data and the absence of a common cartographic basis. IGS-based mapping would permit an integrated understanding of different types of territorial knowledge at different scales, from different sector and disciplinary focuses related to the same city (macro-regional/inter-basin, metropolitan city and neighborhood). However, the culture of secretism also needs to be addressed to do this successfully.

Several networks are formulating and following public policies, but their use of spatial knowledge tools is rather limited. Although experiences of constructing community risk maps are the most relevant, their articulation to metropolitan and district information systems is still pending. Despite the importance of the use of information systems for decision-making and city management, the willingness to build integrated spatial information systems and to invest in strengthening capacities is not recognized. The dominant logic of these services is providing information, not democratizing decision-making in the city.

The use of spatial knowledge instruments for city development is limited to public institutions in charge of cadasters, land registries, real estate investors and corporations, and private consultants. Civil society and social organizations hardly use this tool. In planning terms, we can see that in Peru and especially LM, there is a constant lack of coordination and several conflicts between sectors; levels of government; and between the public, private sector, the civil society and communities during the last 20 years. This situation suggests that update of the Master Plan for the urban development of LM and implementing a transparent information system that would guarantee equal access to spatial information remains fully urgent.

5.1.5. Kalyan Dombivli, India

The E-governance programme in Kalyan-Dombivli is the main local knowledge production system to be put in place through government. It consists of management information systems for internal monitoring, government to citizen interaction through websites providing information and citizen facilitation centres, and citizen to government interaction through grievance redressal systems through both Internet and mobile phone channels. They follow e-governance benchmarks established by the Ministry of Urban Development (MoUD 2010). These benchmarks are designed to streamline operational efficiency at local level, transparency and accountability, and have become part of the mandatory conditions for the national JNNURM programme, with specific guidelines developed for important basic services (MoUD, 2010).

Discourses and rationales for introducing ICT-GIS-based KM in urban governance; boundaries, work processes, mapping needs

In KD, the main discourse behind the introduction of ICT-GIS-based spatial knowledge management systems (e-governance) was to make work processes more efficient, make administration and revenue collection more effective, and to improve LG relations with other levels of government, citizens and the private sector. A major discussion concerned the length of time needed for administrative procedures as well as their high levels of corruption (generally in India). E-governance is considered to be able to provide improvements in both areas. Increasing transparency is further underpinned by the Right To Information (RTI) Act. Improvements in accountability are supposed to be supported by grievance redressal systems, and consultation mechanisms built into processes of designing City Development Plans.

Such discourses on spatial KM are promoted through higher scale government levels – national and state, and draw on a discourse of city development strategies (efficiency, effectiveness, changing urban land markets, slum-free cities) assumed to be an integral part of geo-ICT knowledge systems. Such discourses are promoted by national programmes concerning city development (JNNURM), and programmes dealing with slums (e.g. RAY). Such programmes make the introduction of digitization and spatialized information by local governments mandatory, particularly in areas of property tax assessment and collection, birth and death registration, water supply and citizen grievance registration.

The main rationale is that local government will have better information for administrative procedures, monitoring, and in RAY the idea of community-consultations for slum mapping is included in the documents, although this is more difficult in practice.

The idea of strategic urban planning from the local government perspective does not exist, because KDMC has no mandate to do this (only held by development

authorities for he whole Mumbai agglomeration). KDMC is strategic in terms of 'projects', which it develops in the context of the City Development Plan; JNNURM has provided a framework in which such initiatives are valued and recognized (and financed).

Actor networks in socio-spatial knowledge management in Kalyan-Dombivili

The main configuration of actors in socio-spatial knowledge management in KD is the coalition between the urban local government and the private sector on the one hand, and the local and state government on the other hand. The urban local government was a main driving actor for establishing ICT-GIS knowledge management in KD, through the ambitions of its then Commissioner. Within the local government, the ICT Department comes directly under the Commissioner, but has to maintain good relations with the line departments to ensure that they actually incorporate digital databases for their work processes and for the internal MIS exchange within the Municipality. This latter process has remained difficult, with line departments defending their relative autonomy, especially where it concerns outsourcing of large-scale contracts.

The private company ABM is crucial in terms of developing *software programmes* and for their implementation, as well as for the longer-term rollout of the programme developed for KD throughout Maharashtra. Although the company was contracted to provide hardware for the internal infrastructure, software packages with modules for line departments, implementation of infrastructure and software package, and training for the staff, it has remained a long-term actor within the ULB with substantive and technical dominance.

The link between ULB and citizens is much weaker. CFCs as a decentralized interface system within the city for residents to interact with government officials have been introduced widely. Although the Citizen Facilitation Centres were designed so that residents could interact with KDMC for administrative procedures through their local CFC or online, the online interaction seems to remain limited, even for middle-class residents.

Knowledge building, exchange and contestation, and use

Building knowledge by *developing software* modules for municipal services and *setting-up CFCs* required cooperation between the IT Department, line Departments and the private company. Initially, the weekly meetings promoted cooperation. The head of the IT department played a strategic role in keeping this process going, as not all departments were in favour of implementing software making their working more transparent. In others, such as the Property tax assessment and collection department, one module produced prospective assessments of property values digitally, easing yearly workloads in determining annual valuable rates for each plot. However, in collecting the taxes, existing informal processes remained in place.

The adoption of computerization and digitized databases is still not introduced across the board in KDMC either for internal use (MIS) or for interaction with residents (G2C). Two private sector companies have been heavily involved in implementation, and ownership of the software modules developed remains disputed between KDMC and the companies. Although initially the impetus within KDMC was strong to introduce digitization of databases and the use of GIS, this process has been slowed down by such disputes, so that partial implementation has occurred. Organizationally, management and monitoring of the new systems retains problems.

Generally, the digital monitoring sections of the software programmes have not been activated, so that anomalies in data entry and changes in data cannot be traced (PAG, 2010). Finally, there is a lack of security in using and exchanging access codes of department staff, so that no monitoring can be done of staff data entries and changes, irregularities cannot be traced, undermining the potential of reducing corruption practices (PAG, 2010).

Spatial knowledge produced through participatory processes

In India, e-grievance redressal systems are part of "public feedback mechanisms" designed to increase accountability and transparency of local government. They are considered participatory mechanisms of accountability to citizens, which started from the idea that citizens should be encouraged to help monitor quality of service delivery. However, critiques of grievance redressal systems have indicated that such processes become depoliticized and individualized, and exclude some areas because they are unconnected to digital systems or are not recognized as areas having the right to services.

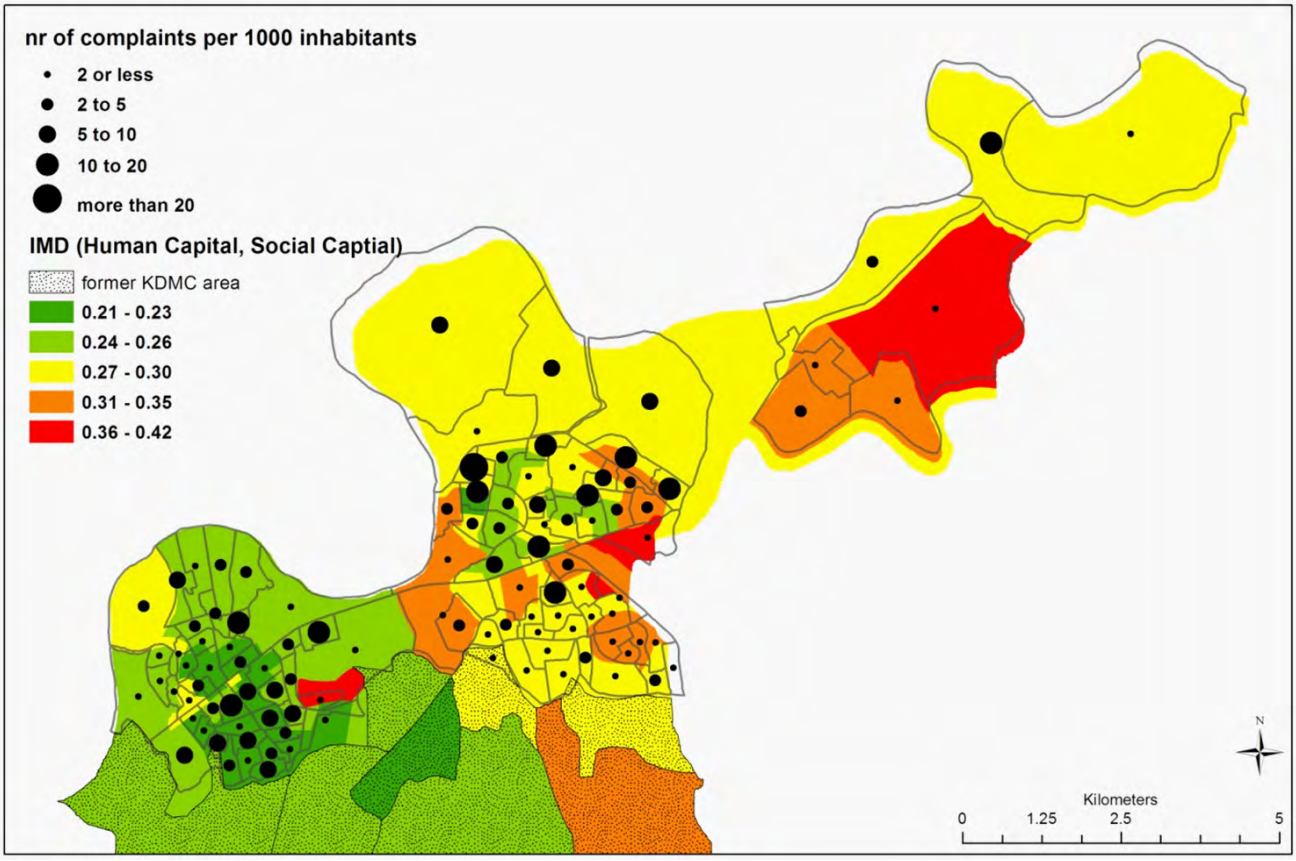
KDMC grievance redressal data was analysed and compared other data sets for its potential use as citizen feedback to local government. Complaints to the local government in 2007 show that more than 90% of all complaints in KDMC are delivered by hand; only 6% are submitted online and a negligible number of people used

the phone to file a complaint. These results might indicate that citizens still prefer to deliver complaints personally, have limited access to ICT, or lack awareness of the possibility of submitting complaints online.

Complaints were registered on drainage, water supply, storm water drainage and encroachments. While the first three deal with malfunctioning of government services, complaints about encroachment refer to the displeasure of more middle-class residents about the informal street activities of other people. The descriptions showed that in many cases these activities were not against the rules. The results suggest that the pressure is exerted by mostly middle-class citizens' demands that officials enforce or create regulations to deal with encroachments, slums, hawkers, and beggars. The map resulting from the KD City Report analysis shows that that complaints are not concentrated in the most deprived areas did not accurately reflect the areas in the city with the greatest need for improvements. This suggests that the e-grievances redressal system does not necessarily capture the requirements of those in most need, but rather those with the greatest capacity for expressing their felt wishes through an ICT tool.

The mismatch between actually deprived areas and 'self-expressed need areas' probably reflects different strategies open to households to cope with the absence or malfunctioning of urban services and differential capability to exert pressure on local government officials. Whereas middle-class residents are more likely to use new ICT tools to express their wishes, the traditional methods of slum residents and low-income groups reflect their dependence on political and patronage channels, and a collective approach rather than individual feedback (cf. van Dijk 2009; van Teeffelen and Baud 2011). Therefore, although participatory processes are useful, the validity of such

Figure 5.1.20: Overlay of complaints as graduated colour (aggregated to 2007 EW boundaries) and Index of Multiple Deprivations (IMD) as graduated symbols (matched to the 2001 EW boundaries); the grey areas no longer belong to KDMC (see further Martinez et al. 2011)



Note: High values in IMD (ranging potentially from 0 [deprivation in all aspects] to 1 [no deprivation]) indicate a high multiple deprivation index. Boundary shifts due to inaccuracy of scanned maps derived from KDMC.

Source: KDMC, 2007; Census of India 2001
Conception and Design: Karin Pfeffer and Javier Martinez (2011); Coordinate System: UTM WGS 1984 Zone 43 N

information feedback systems in reflecting actual needs and the extent to which they contribute to more participatory processes and accountability need to used with great caution (Martinez et al. 2011).

In the KD study area we have also experimented with participatory workshops to elicit tacit knowledge of local officials in terms of high-priority sectors and geographical areas that require particular attention[70]. The experiment has shown that this way of participatory local knowledge construction provides relevant insights into the knowledge of and priorities given by local officials and urban local body.

70 For more information on the experiment see also Pfeffer et al. (2011).

Table 5.1.21: Spatial knowledge management in KDMC

SKMS	Economic growth	Substandard settlements/ poverty	Water governance (environm.)
Types of knowledge included	Private sector knowledge, technical-economic-financial information, political information	City planning information; zoning, redevelopment goals, embedded-political knowledge; embedded-technical knowledge	Technical drinking water information; information on water consumption; economic information, political information
Spatialisation of data bases	Plans for zoning and land use; prepared by private consultants	information not spatialized; rather procedures.	Water networks main spatial data; water sourcing, waste water disposal
Knowledge-building processes	PPPs in mega-projects; private consultants; rarely local community knowledge included	Developers and city officials included in redevelopment plans concerning provision of basic services to the urban poor; local inhabitants often not aware, or only leaders aware; guidelines not necessarily consistent through time	K-D technical expertise (private sector) and political stakeholders; academic consultants (coastal management plan)
Organization and management: Transparency, accountability	Information management and plans influenced by political processes; no transparency wanted by developers; accountability towards own company, shareholders, higher public authorities	Slum boards; politicians, local leaders; Little transparency towards inhabitants, little accountability towards inhabitants	Broader networks of stakeholders; organization controlled by political processes (e.g. concerning introduction of water meter) transparency variable
Political priorities (setting)	Coalition of public authorities 'visioning their city'	Resettlement goals, slum-free cities; international programmes	Water for all (24/7 water supply); maintaining water as resource?
Participatory processes	Processes with local inhabitants limited; consultation with respect to water project?	Limited, unless mandates by financing organizations; probably public consultation when implementing RAY	public grievance system

In the table 5.1.21, the development of SKM in KD is summarized, linking ICT-GIS based systems and processes more integrally to the domains being analyzed in the other WPs.

Materiality: products, platforms, etc.

The e-government initiative in KDMC was started in 1999, and its main elements were in place in 2002. These consisted of an internal IT infrastructure consisting of the IT department established in Kalyan with a back-up server in Dombivili and connections to the CFCs at the administrative ward level and an enterprise information portal for external relations. Further, a large number of software modules were introduced for reorganizing major basic services as well as for internal management information purposes. At the start a monitoring/advisory board of experts (including academic experts) was established to oversee the process.

The *internal IT infrastructure* was designed to change the way that data collection, storage, use and exchange would take place, as well as the way work processes are organized. The first phase consisted of computerization and digitization of service delivery through the development of information modules (MainNET; earlier KDNet). The IT department in KDMC was set up and mandated to develop LG information infrastructure, and to coordinate the input of information by the line departments in KDMC. It did this in conjunction with the private sector, by setting out a tender for a PPP with a private sector company, which would supply 'hardware, software, implementation and training' (KDMC 2000). Each line department was supposed to provide information sets to be developed into modules for the CFCs. Information sets can now be used by citizens for obtaining administrative information, for feedback on existing services (grievances), and for tracking progress of applications by citizens (KDMC 2006).

The second phase would consist of linking the administrative databases produced through the software modules with a *GIS system*, i.e. linking records to the geographical features of the GIS layers created by another private sector company NIIT with the IT and line departments (following JNNURM guidelines). However, the GIS system, put in place by NIIT, has not yet been linked up, which means that a central component of the ICT system does not function yet.

In this section, the information and knowledge products produced within KDMC are discussed and summarized in Table 5.1.22.

The IT department contracted a database with 26-33 layers created within a GIS system through NIIT, which can be used both internally as well as to some extent by outsiders accessing the website (KDMC mapviewer). It contains data for sector one and two (out of 7), pertaining to the historical centers of Kalyan and Dombivili (building footprints, slums, streets, street lights, pipelines etc.), as well as incorporating 10% of the complete property polygon database[71]. The property layer is not publically visible, as the fact that it is not completely up to date may lead to complaints by residents (personal communication).

The TP department produces printed land-use maps as development plans. The department does not collect or

71 The rest of the properties have not yet been entered into a digital system.

Table 5.1.22: E-governance implementation and involved actors

• Internal IT infrastructure + links to citizens	IT department Kalyan, back-up in Dombivili, ABM Ltd., CFCs
• Software modules	All line departments in KDMC Corporation, ABM Ltd., IT department, expert committee
• Citizen Facilitation centres (6)+ head office	Ward offices, IT department
• Enterprise information portal	IT Department
• External advisory system	Expert committee, IT Dept. Head, Commissioner
• GIS-system	NIIT Ltd., IT Department, National gov. through JNNURM guidelines
• up-scaling*: replication of software programme across other LGs of Maharashtra	IT Dpt head, ABM, state government of Maharashtra

* introduced around 2002

use digitized information, but knows about the IT Department's activities. The TP Department's main tasks are land acquisition (for government purposes), building approval, building completion approvals, land survey, and issuing Non Objection Certificates (as a part of CDP) in KDMC, and property valuations (Saharan, 2012 fieldwork report). Nevertheless, the creation of the GIS database also involved the digitization of future land use as mentioned in the CDP.

KDMC has implemented several anti-poverty programmes requiring information collection, including National Slum Development Program (NSDP), Valmiki Ambedkar Awas Yojana (VAMBAY), Swarna Jayanti Shahari Rojgar Yojana (SJSRY), Slum Redevelopment Scheme (SRS), and RAY, mentioned earlier. The Revised CDP identifies 74 notified slums, within a total of 263 slums inside KDMC boundaries (Revised CDP 2011).

The poverty cell within the Slum Improvement Board produces information for obtaining anti-poverty programme grants from Central government. It provides loans and grants to self-help groups (SHG) under the SJSRY programme. It carried out a below-poverty-line (BPL) survey among households in 2005, and based on that 10,195 candidates were selected for assistance. This list of beneficiaries no one is willing to show. The criteria used to put households on the lists are officially 515 Rs./month/person. However, this is such a low figure that very few people be eligible. Councilors have provided LG with beneficiaries to be included. Such information is difficult to access and evaluate as records are maintained mostly in analogue files.

Within the PWD an Executive BSUP Engineer is in charge of coordinating the implementation of the national BSUP mission locally (c.f. section 3). This includes working with private planning consultants, construction contractors, and oversight of construction work and progress. Most of the related information is prepared and stored in analogue files as well as in widely used desktop applications.

Finally, as already mentioned in section 3, the most recent scheme for mapping the urban poor set up by the Central Government – i.e. RAY–is being prepared for KDMC by a special cell set up for this purpose. A KDMC slum survey was done in January 2011, which estimated that 263 slum settlements in the KDMC area exist, with around 91,488 households (Revised CDP, 2011; Saharan 2012). The use of GIS has been specifically mooted as mandatory within the RAY programme. In KDMC two private sector mapping agencies are currently working on pilot projects in A (eastern part of KDMC area) and D (south-western part of Kalyan centre) wards[72]. They are carrying out household surveys and mapping lack of infrastructure (digitally) as basis for the activities to be implemented (Revised CDP, 2011).

The Assessment and Collection (AC) Department (AC; of property tax) has digitized its database, but it has not been linked to a GIS system or remote sensing images. Whereas previously analogue ledgers existed with the information on the valuable rates for properties, now digital databases exist at the CFCs as well as the Head office of KDMC. Entries made in the CFC automatically go back to the head office and are available on both locations.

The Water Department is supposed to carry out its billing through e-modules. These were prepared by ABM under the e-government initiative, but have not been accepted and implemented by the Water Department. The Audits of 2007 and 2010 show that both paper-based and digital systems are used, but are in disarray (PAG, 2010). Mainly, the staff has not accepted use of the digital information system, and there is lack of transparency in its use.

Materiality

The TP department in KD uses Autocad drawn maps for planning schemes, which are not yet available as GIS layers (PAG, 2010).

Outcomes of implementing spatial knowledge management configurations

Expected outcomes of using ICT-GIS-based knowledge found in the literature are: greater transparency, better competencies (efficiency and effectiveness), and legitimacy and accountability towards citizens (McCall and Dunn 2012). In our research, we have also included two other issues: the extent to which knowledge is shared between local government actors internally and with other actors, and to what extent information and knowledge is used for strategic planning purposes.

In the Property Tax assessment and collection department, a strategic department in terms of a strong municipal financial basis, the following major changes were seen in the *re-engineered work process* of property

72 In RAY, slums are categorized – tenable, semi-tenable and un-tenable. Tenable slums can either be on reserved land, in which case the housing has to be developed on a relocation basis. If the land-use is residential, then in-situ development can take place. In KD presently 10 projects are dealing with in-situ development as well relocation. Some of these were listed earlier in other programmes (Saharan field report 2012).

registration and tax collection, based on incorporating expert and codified knowledge from KDMC staff and private company:

- staff reduced from 62 to 24 people
- time needed to register properties for tax assessment reduced from 110 to 21 days
- taxable rates established yearly for all registered properties
- rates are generated through standardized calculations, eliminating corruption in this area
- payments can be made in residents' neighborhood facilitation centre, are implemented immediately; can be done throughout the year
- demand notices for paying taxes are generated automatically, but still delivered by hand– this is still an issue for information transparency.
- Data organization concerning properties has improved strongly, as KDMC data is stored in a central server connected with the CFCs, allowing data to be shared quickly throughout the city. The data have become more timely and readily available to staff and residents
- Revenue collection has increased substantially, increasing effectiveness of the process

A certain number of issues remain. The unsecured access of staff to the digital data systems means security is limited, and software systems designed to monitor accuracy and changes in information are not activated. **Verification** systems to double-check information provided by residents are not in place. Audit reports suggest that residents and staff use their knowledge of 'informal practices' to reduce tax rates and input alternative data into the digital system.

In terms of *organizational changes and sharing information*, the digitization process streamlined data management and information infrastructure. However, barriers still remain in linking the databases to geographical information systems (GIS) limiting their usefulness for verification and monitoring processes and identifying spatial patterns.

Local government staff still has too little understanding of the technical requirements of building digital spatial knowledge system, nor of the GIS software intricacies or hardware requirements (cf. Richter 2014). In KD the urban local body focuses on developing a digitized spatial knowledge management system primarily as management information system (property tax collection, grievances). The spatial information products generated are 'administrative' databases or contain administrative information. There is no initiative yet to utilize such sources of information for more strategic monitoring or planning purposes, such as found in South Africa.

As the digital KM systems from KD are being rolled out across the state to local governments, analysing local – provincial level government networks should provide new insights on multi-level governance kin the future.

Local government works closely with private sector companies in developing hardware networks and software modules for the SKM system. The private sector is a primary producer of spatial knowledge, utilizing lists, paper maps, remote sensing images, and other sources of data. Ownership of software modules is strongly contested between both actors, and the private sector seems quite strong (PAG, 2010). The private sector also refuses to 'empower' local government staff by providing continuity in training, to a level of competence that they become independent of the private company's technical assistance. This 'coalition' therefore retains strong tensions because of struggles over ownership of the SKM processes.

However, within LG street-level bureaucrats resist the introduction of digital databases with some success. The fact that the property tax database has not yet been linked to the base-map of the GIS system makes tracing discrepancies in property tax information difficult, and the fact that monitoring systems in the software have not been 'turned on' means that the transparency of changes made in billing and payments is non-existent (cf. PAG, 2010; PAG 2007).

The main change found in LG due to ICT-GIS based systems is in the increased information provided through the KDMC website, and the much greater efficiency and effectiveness of administrative procedures through the CFCs. Paying taxes has become much more standardized (transparent) and quicker for citizens, and more effective for local government in generating revenues.

The link between local government and communities is much weaker. Local communities are holders of community-based and embedded knowledge from practice. However, they are not usually recognized as such or included in the SKM processes of local government. Mainly middle-class residents generate and provide community-embedded knowledge to local government through grievance systems, but do not have the power to force LG to take up grievances effectively. Weaker economic groups or socially marginalized groups do not work through digital systems. Drawing out both residents as well as political representatives' knowledge from lived

practice is quite possible, as shown by the participatory workshops held in KD (cf. Pfeffer et al 2011). However, it is not general practice in the city.

Citizen to citizen initiatives are not common in KD to our knowledge. However, community-generated digital networks exist in Mumbai and are active in generating knowledge about spatial and political issues there (AGNI, Karmayog). This does not yet seem to have spread to the whole agglomeration.

We can draw the following conclusions about the extent to which knowledge management systems are participatory. In the current LG spatial knowledge management system, urban residents are largely excluded from major forms of participation or consultation. There is outreach through the decentralized CFCs, but the only feedback to government is through grievances, ward councillors or self-help groups. The grievance system is utilized mainly by middle-class residents, and excludes other social groups. In anti-poverty programmes, political representatives are included to some extent, but contest information provided by LG.

For citizens, there is more transparency in the calculation of taxes, but little or no empowerment. It can be said that there is greater respect for entitlements, as the calculation methods are now standardized and interfered with less. Only volunteered geographic information provides the possibilities for empowerment at a collective level. The sources of knowledge included concern administrative information and do not include lay knowledge, with the exception of grievances.

The main changes in outcomes are found to some degree in legitimacy (tax calculations) and accountability (Grievances, website). These initiatives are most favourable for middle-class citizens. The lack of transparency within the Basic Services for the Urban Poor (BSUP) progammes and databases suggest that neither poor households nor their political representatives are experiencing benefits from the new knowledge information systems currently.

5.1.6. Chennai, India

Discourses and rationales for introducing ICT-GIS-based KM in urban governance

The discourses on introducing ICT-GIS-based knowledge management vary across organisations in Chennai, but mainly there is a focus on increasing efficiency and effective work processes within existing mandates, aimed at improving administrative processes and revenue collection, in which digitization and geo-referencing is considered supportive to provide good databases and support monitoring. Implicitly embedded in these discourses are the issues of better monitoring and surveillance against tax avoidance and illicit tapping of municipal services. Civil society organisations map needs and existing service provision for engaging with local government. None of the existing organisations frame their rationales for using mapping to strategically redesign the city.

Actor coalitions in SKM in Chennai; power relations, scale and arrangements

The main characteristic of the actors involved in Chennai's urban planning and management and their use of spatialized digital information is the silo character; there is no network of organisations, which work together in Chennai. Although a network of major government organizations dealing with Chennai urban issues was constructed under the auspices of the Department for Municipal Administration and talks went on for about two years about the possibilities of integrating base maps and making databases compatible and accessible, it was found difficult to make much progress on either issue. At the moment state, metropolitan, and local government organisations each have their own SKM initiatives.

Various government organizations in Chennai started initiating digitization from the 1980s onwards, with the help of international agencies or the national government of India. The CMDA has the longest history of ICT-GIS information in house, which is used for basic mapping purposes and not strategic planning. Other government organisations have found that introducing departmental ICT-GIS is possible, but integrated systems including all organisational departments have not been successfully introduced.

Two other types of actors are important in influencing urban planning and management discussions; the private sector and civil society organizations. The local and regional real estate sector is a major producer and user of spatial knowledge, especially on land-related information like ownership, land size, land tenure status, although very little is known about these companies work. Their influence in Chennai has been strong in the IT corridor whose development they have strongly influenced.

Some NGOs have introduced community-based initiatives using and producing ICT-GIS based information and knowledge. One has crowd-sourced information on issues important to residents in Chennai, mapped them, and used the information gained in negotiating with local government to improve the situations found.

Spatial knowledge production, exchange, contestation and use in urban and regional planning

The Chennai Municipal Corporation (CMC) has ICT-GIS initiatives in several Departments; property tax assessment and SWM are important ones. The digitized database for property tax assessment and collection is not kept up to date (at least up till 2006), and does not match with that of the Water Board, which it should.

The property tax assessment and collection department provided almost half of the city's budget revenue in 2006-2007, and 25% of all revenues in 2011-2012. Because the registry of properties lagged behind in the period of the early 2000s and because of missing assessment, the CMC missed out on 31% of taxes, which should have been collected, and 13% of total revenues for the 2005-2006 fiscal year. Internal validation and process controls were much less of a problem.

In the SWM Department, early experiences with subcontracting areas of Chennai to private waste collecting and disposal companies (Onyx) led the Department to provide carefully crafted area maps indicating routes of waste collection, intermediary and final disposal descriptions as integral parts of the contract negotiations. These are complemented by daily reporting of actual collection and monitoring systems based on mobile phone picture collection by inspectors, reported to the central office. The major effect of these directive information systems and process controls has been that trouble shooting is delegated to zonal and ward level, leaving the central SWM department time for strategic planning of SWM (pc 2012).

The Chennai Metropolitan Water Supply and Sewerage Board provides for water supply and sewerage needs of about 651,000 properties in the old Chennai metropolitan area. The main sources of revenue for the Board are water tax and water charges; the former for house with no meter, and the latter for houses and companies with meters.

Digitization of the internal information of the Board started in 1986 in functional and administrative activities, using stand-alone systems. The process of integrating these systems within the organisation, taken up in he early 2000s and was carefully orchestrated, starting with a pilot and then being rolled out further, connecting their headquarters office with all 161 depots and 10 Area offices. In 2010, the Audit found that two areas had not yet been included; the new water connections and the complaints systems, because data entry was still being done manually. The lack of data on new water connections and billing processes resulted in total losses of the Board were calculated at 42.69 crore Rs. in the audit period (see Chennai City Report 2014). Because there was no geo-referencing of the complaints, internal monitoring using this database was not possible. Nevertheless, the increasing number of complaints (around 78,000 in 2012-2013) on sewerage blockage and contamination of drinking water would suggest that this would be useful.

The Water Board makes use of spatial representations of the water infrastructure, in particular the location of pipelines and associated infrastructure, and location of water users with meters. Currently these maps are mainly drawn in Autocad, although some information is available within a GIS. Although there is a move towards using GIS more effectively in producing knowledge on water provision and use, there are few people with the necessary skills with the Water Board. The necessity for it is recognized, as currently the spatial information and knowledge building is available only in embedded form among line workers (see also Jameson 2014). GIS could also help identify areas where pipelines come together to avoid accidents in repair works. There are also plans to incorporate tracking GPS in the routes of water tankers in order to monitor water provision and make this means of water supply more efficient.

The TN Slum Clearance Board is currently the nodal agency for the RAY programme dealing with slums, which introduces spatial mapping of slums (in GIS) with unique identifying systems for households. The main goals of RAY are defined as making a situational analysis, and devising curative and preventive strategies for slums, including development plans, investment requirements and institutional arrangements. It is being rolled out across a large number of Indian cities, including Chennai where several zones have already been mapped and zone-level Plans of Actions are being prepared. Use is made of private sector consultants in the process, with the help of councillors from each electoral ward to identify existing slums and whether they want to be included in the programme. The process in practice is much fuzzier than the Programme goals and Plans state, and it is still rather premature to draw further conclusions at the moment. The initiative is an interesting one, because it targets the production and use of spatial knowledge so strongly, which has not happened before.

Change in Boundaries and protected areas

In 2011the Chennai Corporation area was expanded about two times its original size to 426 sq km, with the metropolitan area most likely to be extended to 8,878 sq

km. The main purpose was to accommodate the growing population and expanded IT corridor to the South of the city. Because the IT corridor now falls under the Corporation jurisdiction, new structures of representation through ward councillors have been put in place. This has rather reduced the strength of local populations to negotiate with LG, as negotiations now have to take place with the LG of total Chennai.

Within the extended area several lakes exist, which currently are protected from development officially[73]. The catchment of the marshy area in the South connected to the Buckingham canal and providing a link with the sea is 'protected'. However, expanding building developments in the area show that this protection is limited in practice.

The Chennai metropolitan area displays two development lines, a red one (current) and a blue one (future). Within the blue line land use change from agricultural area to urban area will take place; as rain-fed agriculture is no longer profitable under the prevailing climate conditions, and it is expected that farmers will agree to sell their land.

Producing, exchanging knowledge in ICT-GIS based systems in urban and regional planning

The Chennai Metropolitan Development Authority (CMDA) deals with urban and regional planning in the wider metropolitan area, and uses several planning products and instruments incorporating spatial information; Master Plans, a land information system which covers only the layout of the Chennai Port Trust area, the Coastal Zone regulation, the determination of FSIs, and the utility mapping project.

In the utility mapping project, set out by the Union (national) Planning Commission a combination of produced knowledge is envisioned; the development of a digital base map on a scale of 1:10,000 to support government departments in formulating schemes and the planning of infrastructure; integration of physical information derived from aerial photographs for greater Chennai from 2007, provided by the National Remote Sensing Agency in Hyderabad and handed over to the Survey of India which is in charge of the digitization process including attribute information. The CMDA should combine this with detailed field surveys to update and to provide information on basic services as well as information with respect to police and fire. However, the utility-mapping project linking various departments and authorities has been in discussion for over two years without much progress. Its usefulness would lie in strategic planning for carrying out new plans that cover large parts of the metropolitan area.

The relations between local government CMC and the metropolitan CMDA reveal some tensions in their cooperation. The CMC had limited interest in participating in discussions on preparing the Master Plan, as its mandate focuses more on daily operations and maintenance of basic services and less with future visioning. Collaboration concerning GIS-based mapping activities is not always smooth. Property information is not shared between the two organisations, which use different sources of information for preparing maps on land use and ownership. Other organisations again use different sources of information for property mapping (Revenue department and survey office within the district collector's office use a tool developed by NIC at Union level, with a base map validated by the GOI). CMC cooperates with the NIC, which prepared aerial photographs for Chennai, which should serve as a basis for digitizing utilities, line features.

While Chennai Corporation relies on the support of the Survey of India in terms of the base maps, CMDA develops everything in-house, working with ESRI India. There is realization of the importance of moving towards a common database with geo-referencing and common base maps within the CMDA, but the organisational networks, competencies and mandates still pose barriers. The issue of unwillingness to share knowledge is a wider problem in the Indian context.

Spatial knowledge construction in preparing the second Master Plan

The construction of the Second Master Plan by CMDA is strongly based on digitized information (in both Autocad and GIS), and training in GIS was provided to senior planners through Madras University at the start. The CMDA area is divided into several thousand blocks, with spatial information on land use extracted from satellite images. Land use classifications from these images are extracted by senior planners, based on their professional knowledge and experience. Although the GIS department within the CMDA prefers to draw maps in Autocad, the detailed development plans are further processed in an ArcGIS platform. For the detailed development plans a detailed physical survey is carried out with respect to land use, and that information integrated in the attribute table of the ArcGIS map.

In preparing for the Second Master Plan, the CMDA has introduced *consultations* on local areas plans linked to the MP, conform new legislation. Meetings were organized in

73 In the 1970-80s many lakes were reclaimed in favour of housing schemes, established with World Bank funding,

local languages presenting the Master Plan to local residents, invited through newspaper announcements. The organisation of meetings was done in teams to cover the different geographic areas and spread over seven months. In total more than 1,500 *objections* were submitted. Each written objection has been discussed and dealt with by a committee. The outcomes are visible in the final version of the MP. Largest concerns found were traffic, parks and playgrounds.

Mapping slums for redevelopment and consultations: the RAY process in Chennai

Slum mapping and preparation of action plans for slum redevelopment are major dimensions of the national RAY programme. In practice, these are very labour-intensive processes, and the purpose of slum mapping is not entirely clear, if related to the subsequent activities outlined in the programme description. In Chennai, Darashaw, a private consultant[74], has been given the task of preparing zonal maps of slums and the related Plans of Action for selected zones in Chennai. Preparing slum maps consists of: enumerating slums in each zone, conducting a socio-economic survey, preparing manual topographic base maps of the settlement, with geo-referenced coordinates for its boundaries, transferring the data into GIS software. Subsequently, data analysis is done, using a deficiency matrix to prepare development options showing priorities and phasing, investment requirements and financial planning. Consultation with councilors, approval of the slum-free zonal Plan of Action from the State-level Review Committee and final sanction from the Central Review Committee follow this process. Currently (Sept 2013) zonal maps have been completed for 13 out of 15 zones of the CMC. Although the RAY guidelines show that leading NGO/CBOs should be engaged in community mobilization, slum surveys and preparing slum-level redevelopment plans, this is not the case in Chennai, where leading NGOs are not involved in the local implementation of the RAY program.

The entire work from data collection to analysis is being done by the private consultant Darashaw, with no capacity building and training for TNSCB staff included, although they are the lead state agency for RAY. The policy guidelines of RAY mandate the use of total station survey for mapping slum infrastructure, but this was abandoned after the first field experiences in Chennai. Now, the consultants prepare a manual topographic base map of the settlements comprising of housing blocks and related infrastructures. A basemap for CMC using Quickbird imagery provided by the NRSA was made (not legally validated).

In Chennai, the choice of development model and resettlement for surveyed locations was based on private sector analysis and comments from TNSCB, bypassing residents in selecting the development model. In some instances, the survey results were presented to slum residents, although the majority are unaware of RAY policy. This puts local leaders and councillors in a powerful position because they can access knowledge as well as those collecting slum data. For the RAY survey 935 undeveloped slum settlements have been mapped in the 13 zones of CMDA. Although, resident participation in decision-making, capacity building of local government, and engagement of local NGO/CBOs are key concepts in the policy guidelines of RAY, they are missing from policy implementation in Chennai.

Categorization, in-situ redevelopment, land titling and resettlement

In the core principles of RAY program, the slum survey is viewed as a preliminary step toward security of tenure, regularization and free delivery of *patta* titles. In situ rehabilitation and infrastructure development are the preferred options, bringing existing slums within the formal system and enabling them to access the same level of basic amenities as the rest of the city. However, in the existing draft zone report for Chennai, no priority is given to regularization. The Tamil Nadu Slum Clearance Board continues to consider relocation as the core strategy of its policy for Chennai. Land values of squatted area should be valorized and inhabitants reallocated in peripheries in block apartments where conditional free pattas apply, like in Semmenchery. NGOs like Transparent Chennai and inhabitants are contesting their preferences. RAY's guideline envisions the "Preparation of legislation for assigning property rights to slum dwellers" going hand-in-hand with the Slum Survey, but there is no coordination with Revenue or Survey Department and digital property mapping.

The release of funds under RAY does not take into account the function of the Slum Survey and Plan of Action report, which is supposed to be ratified by inhabitants on the premise that in situ redevelopment should receive priority. Currently, reporting has much more to do with land portfolio management than participative development.

The consultant makes the basic distinction on in-situ redevelopment or relocation by distinguishing between tenable and non-tenable slums based on environmental

74 Darashaw is a leading investment and banking house from Mumbai which provides advisory services in City developmental projects and urban infrastructure. Investment planning is the core competence of the consultant, not participation and in situ development.

hazards, and on encroachment on infrastructure. Coastal zone regulation (CRZ) also sets limits.

Eligibility for new housing is limited to owners of house structures; tenants are not entitled to anything. Ration cards are needed as basic proof of residence for being on the list. Only hut dwellers could be enrolled in the scheme; not those living under tile or concrete roof. The universal enrolment invoked for a Slum Free City and at the foundation of RAY Vision is limited in practice in the process of listing and entitlement of places, constructions and households. From the Zonal Survey a plan of action based on a deficiency matrix is prepared–Slum Free City Plan of Action (SFCPoA). It is followed by a yearly phasing, including pilot projects and a financial plan divided between infrastructure and housing costs. Spatial analysis combined with a matrix of deprivations leads to four broad approaches: slum improvement, slum up-gradation, slum redevelopment and slum resettlement. The redevelopment option with densification and remunerative use of land is usually given preference.

During implementation of RAY in Chennai, mapping, digital data collection, recording and identification appear as a set of tools providing a scientific/technical rationale for decisions on upgrading or resettlement, and as such more an instrument for profiling and controlling than for shared consultation and decision-making. NGO and CBO participation is almost nil.

Spatial knowledge produced by the private sector

Important actors in the private sector producing and providing spatial information to investors are local and regional real estate developers and international property consultants (IPC)[75], producing spatial and land-related information to identify areas for company investment. There is still little use of cartography, unless the real estate project is quite large, when partnering is done with GIS companies in order to produce advisory reports. It produces city maps portraying business districts, attractive middle-class and elite residential areas, and good areas for large company investment (IT). These maps leave out the existing urban fabric of small-scale economic units, local shopping markets and less upscale housing areas.

The information provided by the real estate developers and IPCs is a knowledge network independent of government-led urban planning and management.

75 This description is based on a contribution and recent research by Rouanet (2013).

Spatial knowledge produced through citizen participation processes

Transparent Chennai (TC) is a leading local NGO aiming to collect and disseminate data and research on urban planning, governance and civic issues. It has four main field of work involving public participation and advocacy: i) participative and voluntary web-mapping where citizen can introduce information or where community collected information can be diffused; ii) reporting on public hearing, planning activities, conduct community meeting, conference and advocates for a more inclusive, pro-poor and participative city in the press; iii) conducting its own surveys with a network of NGOs and volunteers on civic issues; iv) leads participatory mapping in poor neighbourhoods concerned by upgrading or resettlement and conceived a toolkit for slum community mapping.

TC works with a network of local NGOs and larger intercity alliances, and is supported by the Centre for Development Research, Institute for Financial Management and Research (Chennai). Its survey campaigns succeed in mobilizing through various social media a large community of volunteers (young engineers, up to 200) who provide a set of accurate geo-referenced data on bus road, public toilets, and homelessness hotspots. TC's initiative called "Map Your Bus Route" used My Tracks Google Android platform allows volunteers to report on their phone and progressively build a map of Chennai's bus lines, a facility which was not available.

This approach challenges the lack of accurate and updated public information in the city, and makes it possible for TC to criticise the data and maps provided in-house or through consultant reports used currently by CMC and others producing geo-referenced information who fail to incorporate and disseminate to the general public accurate and up-to-date geospatial information. This information can also be used to evaluate and monitor government actions and investments.

Materiality

Spatial knowledge management is linked strongly to the main mandates of organisations, with an emphasis on administrative classifications and information. This type of technical organisational knowledge remains confined within organisations, with no possibilities of knowledge exchange across organisations dealing with the city area as a whole. Initiatives to collaboratively develop and exchange information among government organisations at local and state level are stymied. Community-based

types of knowledge from lived experience of social groups are not recognized in government organisations, and existing guidelines and rules cannot accommodate them.

Changing outcomes

In Chennai, there has been a gradual introduction of digital data(bases) into most organizations, coupled with a gradual changeover from Autocad to GIS which is still in very early stages in most public sector organisations. This means that technically integrating databases within and between organizations is still difficult, due to the limited geo-referencing available for layering sets of attributes. Within public sector organisations, integrating ICT-GIS has not been successful until now, nor used to maximum purpose, and is usually limited to the departmental level. This is a commonly recognized issue across the world, but needs to be dealt with before the maximum benefit of digitizing and spatializing knowledge management can be reached. In Chennai, two organisational issues exist: there is a lack of organizational capacity and directive steering to overcome the lack of knowledge and resistance of staff, and if ICT-GIS-information is better integrated, levels of revenues obtained by public sector organisations would increase, allowing them to produce better results from their work.

Although an organizational network of public sector organisations within the city (including state government organisations) was set up several years ago, it has not yet been successful in agreeing on how to connect and share maps and databases for monitoring, evaluation, and future planning across the city in a more integrated manner.

Separately, the private sector produces its own spatial information and 'landscapes' for investment purposes, which is separate from either public or civic initiatives, and works for its own set of private investment actors.

Participatory processes including individual citizens and civic organisations are just beginning to be accepted in certain stages of urban development processes, and their role is limited to respectively grievances and consultations. NGOs are doing participatory mapping in the areas of public service information and environmental mapping of areas to be protected (marsh), and engaging local government in order to push forward their improvement agendas.

In conclusion, the situation is one of many and various initiatives, suggesting a fragmented configuration, with potential if the various actors would work together in a more coherent manner.

6 SKMC and Its Influences: Comparing National and City Contexts, and Domains

In this chapter, we compare the ways that spatial knowledge management has been developed and integrated in the various cities in this research project. Our approach to city comparisons is based on the following assumption. First, city development happens within a historical context influencing the trajectories of city development. Second, we employ a relational approach which recognizes that configurations of discourses, actor networks and coalitions and opposition shape city development in particular ways by their framings, power relations and focus. Third, , our comparisons are interpretative, based on the knowledge and experience of our research teams embedded for longer periods of time in each of the cities concerned, with knowledge and experience from both practice, lived experience, and the fieldwork carried out with scientific protocols of conceptual frameworks and fieldwork guidelines. Finally, this process has been an iterative one, building on exchanges of knowledge and insights within the research network, and the large number of post-graduate students (more than fifty in total) who have participated in the project, by doing their master and PhD thesis work in the cities concerned.

We compare here first the historical context of the different cities concerned by assessing the ways in which (participatory) spatial knowledge management in cities has been supported or driven by national and provincial policies in the four countries concerned–South Africa, Brazil, Peru, India **–,** and the extent to which SKM has been integrated and utilized in the various domains of urban development.

6.1. Influence of national policies concerning SKM: production, integration and utilization in urban strategies

South Africa

South Africa is the country with the clearest national policies concerning spatial knowledge management, linked to their policy goals of reducing existing spatial segregation and inequalities. This has provided a strong rationale for introducing, integrating and utilizing the outcomes of spatial knowledge collected through national and local public sector departments. The country has a national spatial data infrastructure in the Ministry of Rural Development and Land Reform, where the national geo-spatial information system provides standards for data systems, and which works on integrating databases and mapping.

It has been strengthened by the extensive staff expertise concerning ICT-GIS existing since the 1980s within large municipalities (Durban, Cape Town), which has made it possible for local government to develop the interactive GIS databases and analytical tools, which provide evidence for prioritizing local policy choices. As the generation of municipal staff with such expertise is gradually retiring in the next decade, it is crucial to ensure that new expertise is trained and recruited for such positions. The higher education system supports this by solid programmes in information and spatial sciences.

At the local level in Durban, the GIS databases by department and for the Corporate management of the city provided the spatial knowledge to effectively design changes in the city, based on an analysis of recent data. Because of the online-accessible GIS database, municipal staff could re-classify their information based on their discussion, discovering what would be more inclusive and appropriate classifications and allowing them to carry out interactive processes using the data in real-time analysis for developing policy and implementation priorities.

Brazil

In Brazil, developing GIS was informed by a larger movement for developing ICT-GIS systems for public policy that started in mid 1960s under the military government. The National Commission on Cartography (CONCAR) set basic guidelines for Brazilian cartography throughout the country. The Federal Government also launched an ambitious national development plan for the whole country, which shifted the focus when democratization increased the importance of social movements nationally and globalization started to expand, incorporating new elements into processes of data producing and management and mapping.

In 2010, the National Spatial Data Infrastructure (INDE) was officially launched by the federal government to integrate technologies; policies; mechanisms and procedures for coordinating and monitoring; standards and agreements for facilitating and normalizing generation, storage, access, sharing, dissemination and use of federal, state and municipal geospatial data." (www.inde.gov.br). This means that national standards for developing and maintaining public databases are mandated, establishing the level of meta-governance.

The Brazilian Geospatial Data Depository (DBDG) was implemented to integrate various public data sources, and the portal "Sig Brasil" was designed as a platform for providing access to data and data dissemination, following simple, fast, comprehensive and integrated procedures accessible to non-expert audiences. The Portal "SIG Brasil" is running but initiatives to make public data available on the Internet and easily accessible as instruments for public planning, general information and accountability are taking longer. Most information on the Internet under these initiatives is not explicitly spatial or is provided in various nested spatial scales.

The Brazilian Institute for Geography and Statistics (IBGE, national census bureau) has acted as an important portal for disseminating a variety of socioeconomic and demographic data, as well as layers with territorial boundaries (census tract, district, municipality, state, major region and country) allowing for mapping and displaying in a GIS environment. DATASUS (www.datasus.gov.br), a comprehensive system integrating several subsystems for data on **health** for the whole country at various scales has significantly contributed to setting standards for data collection, data quality, data storage and data dissemination, which have positively influenced other federal ministries and departments.

At the state level, the Sao Paulo Metropolitan Planning Company EMPLASA (www.emplasa.sp.gov.br) is an important depository for geospatial data in the state of Sao Paulo. Its data depository has been mainly used for EMPLASA's own work on the area known as the Paulista Macro Metropolis (MMP) including the four metropolitan regions in the state. It is only fairly recently, that EMPLASA has launched some initiatives on data sharing with municipalities in the Sao Paulo Metropolitan Region. This means that such information is marginally accessible to urban local governments.

This means that in Guarulhos, initiatives on spatial knowledge management have very much been carried out independently by local government, and funded through local resources. The CorporateGeo Platform is being developed for the municipality to provide data covering administrative, socioeconomic, cultural and environmental issues of the municipality, designed to create a secure data environment, improve data quality, provide added-value geospatial products (maps, indicators, metrics) and maintain an up-to-date data warehouse able to supply information for increasing demands.

The initiative around environmental disaster and prevention are an area of initiative in Guarulhos, linked to local leadership within the municipality. This shows how initiatives in one domain can serve as examples to build broader GIS-systems within local government.

The municipal government has made a significant investment in increasing assess to information for ordinary citizens, by user-friendly Web portals and interfaces as well as creating Internet public kiosks with free access to computers in low-income neighborhoods. However, processes for producing spatial knowledge through citizen participation are rarely present.

Peru

In Peru, the degree to which spatial knowledge management is integrated into the public sector and society is relatively low compared to South African and Brazil. The government has set up a national spatial data infrastructure (CCIDEP), which is designed to streamline the coordination between the different agencies producing ICT-based spatial information. In general, organizations in charge of generating basic climatic, physical and socio-economic information useful for measuring socio-economic trends, city vulnerability, adaptation capacities belong mostly to the different ministries of the national government. Currently, many government institutions lack the ability to keep their information up to date, and to expand it further. This means that existing information is either not accessible, too expensive or out of date.

Generally, spatial information management systems in Lima Metropolitana (LM) are partially developed; institutions have very low budgets and initiatives are fragmented. This means that efforts are duplicated and the generated cartography cannot be matched due to the use of different geo-referencing systems. Ministries and local governments use these systems mainly for mapping facilities and infrastructure, for determining boundaries, zoning, and for developing large infrastructure projects, among others.

The use of GIS technologies is widespread in the business sector –such as real estate–, state sectors with higher levels of modernization –such as transport, basic service providers, high income municipalities–, and academic and professional sectors linked to globalization processes and large-scale infrastructure development. The Ministry of Housing, Construction and Sanitation (MVCS) has embraced the idea of private sector leadership by seeing its role as one of supporting the private sector, generating information for facilitating real estate investments. According to this Ministry, the private sector is the main developer of Metropolitan Lima, and the Peruvian state should support it by providing spatial knowledge for future investments.

Private sector institutions that develop spatial knowledge instruments such as think tanks and consultants rarely share their information and sell it to others at very high prices.

For most middle-class district municipalities in LM the urban cadastre has a well-developed GIS system, providing up to date and precise measurements, and geo-referenced allocation of plots. However, they are stand-alone systems, and not inter-connected. High-income districts have a web-based cadastre, considered to boost productivity and investment in those areas, and is linked to the pro-growth discourses within the city and the country.

The Callao regional government initiative to set up an integrated GIS network together with the local municipalities, and bringing together other stakeholders as well through a *concertación* process, is a strategic example of a well-integrated set-up. The combination of establishing precise boundaries, putting in place socio-economic databases, and producing new knowledge on specific topics identified with the help of stakeholder forums in the region, linked to a webportal which gives access to all stakeholders in the region, provides a strong knowledge management network across scale levels of government and civic organizations.

Essential to the initiative has been the leadership within the regional government, which has provided the expertise and continuity, necessary to push through such initiatives effectively.

India

In India, the introduction of policies concerning spatial knowledge management have been spread across several Ministries and has been generated by initiatives at local, state and national level. Initiatives have not been coordinated, and it is not clear that policies have travelled across scale levels of government, nor have

they been evenly developed between the various states. This makes it very difficult to say anything general about policies and their implications in India. However, a number of common issues can be identified which are the result of policy influences on spatial knowledge management in India.

The first concerns the issue of spatializing information. The Survey of India (SoI) is the only organization with legal authority to issue maps, which means that all levels of government need to use these maps for the planning. However, these maps are in the process of being digitized and are very difficult to obtain when it concerns areas considered sensitive because of security reasons. This pertains to the whole coast, and includes a large number of city areas, which lie on the coast. This introduces a catch-22 in terms of urban planning, which cannot be done on legal maps, as these are not accessible. The NSDI (National Spatial Data infrastructure) in India is government-led and very top-down, with little input from lower levels of government, private sector or users. This has meant that progress is uneven, with little interaction between national and state or local levels for standardizing protocols.

The second concerns how databases are compiled and distributed between different scale levels of government. For socio-economic data (Census) the data is collected locally, but integrated into digital databases at the national level (Registrar General). Urban local government can receive the databases back again, but often does not have the capacity to further analyze and use such databases. The Development Authorities, which cover developments in the larger areas around cities, have much more capacity in house, and use it to provide support for local planning of facilities and infrastructure, but do not transfer that capacity to local governments.

The third issue concerns that urban planning until recently has been sectoral rather than spatial; i.e. funding has come through line departments rather than being allocated through an integral urban planning process (the Master Plans have been delinked from the funding necessary to implement them). This situation is shifting due to the large-scale national funding schemes which are directed towards local government of cities, which now allows them to plan more in terms of strategic projects for the city as a whole, and has made the spatial focus much more important for allocation and monitoring (JNNURM). This scheme has also made it compulsory to include digitization of internal databases of local government to obtain the extra funding. The main rationale behind this condition was that SKM in local government would increase efficiency, reduce corruption and make local government more effective. Improving the administrative interface with local citizens (mainly middle- class) through webportals and local facilitation centres was part of this policy. The new Master Plans being developed also include more attention for nested planning through local Area Plans, and utilize satellite images for determining zonal land use (Chennai).

National sectoral policies are also increasingly including mapping with GIS as part of their design, although it does not always seem clear what the rationale or value added is. The national RAY programme, for dealing with slums, is a case in point, which seems to be working out unevenly in practice. Another national initiative linked to regional levels is COLLABLAND by the National Informatics Centre (NIC), which is gradually producing plot-level boundaries and a database on ownership and plot size which could start functioning as a cadastre (Tamil Nadu).

The lack of very coordinated policy at national level has meant that initiatives are taken locally in many places (such as Kalyan Dombivili), sometimes by the local government as a whole, sometimes by different line departments which saw the usefulness of such spatialized digitized knowledge management (e.g. solid waste management depts., water boards). Currently, it is impossible to generalize across the wide variety of such local initiatives in India, except to suggest that the variety of software programmes used and local classifications produced will make it very difficult to introduce national standards for such databases at a later date.

Private sector companies have been very active in producing software for spatializing and digitizing data and maps and have dominated the scene both for their private clients wanting to invest in urban areas, as well as in the public sector, where they provide the necessary expertise, and often retain power over it and display an unwillingness to transfer such expertise to the public sector staff.

6.2. Comparing influence of city contexts; Capital cities, regional hubs, cities in agglomerations

The second type of influence consists of contextual influences–location and embedding of cities in the city rankings. In the cities of the research project we distinguished capital cities (Lima, Delhi), regional hubs such as Chennai, Durban, Callao and Cape Town, and medium-size cities in large agglomerations, such as Kalyan Dombivli and Guarulhos.

In capital cities contrary forces are at work in urban development – on the one hand, local government is close to the national seat of power and aware of new developments, on the other hand, it is interfered with more by national government ministries taking over local mandates and its powers curtailed. Especially when different political parties are in power at local and national level, the processes of removing local powers or not mandating power to local government is used as a means of limiting political power. Both capital cities were the arena of early national spatial data infrastructure experiments (from 2000 onwards), which have both become somewhat locked in into struggles between ministries on their mandates concerning specific issues in SDI, such as the access to legal maps in India, and the lack of access by local government to the Limean water company's data. Not resolving such issues nationally prevents the main purpose of a national spatial data infrastructure from being reached, namely the development of metadata standards and protocols, and coordination between databases deriving from different sources in the country.

The greatest variety of NGOs bringing in community-based knowledge for advocacy purposes is found in the capital cities. Despite this, the level of expertise in SKM remains quite limited, with mapping still being used as visualisations (through Google Earth) and linking maps to databases for trend analysis very rare. The lack of links between universities where such expertise is available and NGOs or local communities prevents such initiatives from becoming more common. Where these do exist (or have been developed in projects – such as in Lima), the information provided can become a strong advocacy instrument (see Miranda Sara and Baud 2014).

In regional hubs, greater scope for local initiatives (i.e. less interference from national government) comes together with relatively high levels of competences within local government, private sector, NGOs and academia linked to the regional function of the city concerned. In Durban, Cape Town and Chennai we have found a plethora of experiments and initiatives concerning the use of spatial information for urban development. In South Africa this has led to well-developed municipal databases, which are used for trend analysis and provide inputs to policy framing and implementation. The strong national policy context is an essential support in this. In Chennai, India, different municipal departments and the CMDA (development Authorities) have developed their in-house digital spatial databases (or on paper) for their own work processes, and an attempt to integrate the digitization of databases for management information system within local government was made but abandoned in the early 2000s. The plethora of national and state initiatives designed to get state government organizations coordinating matters in Chennai for TN, is unevenly developed and overlaps with local government initiatives. Chennai sees as its competitors other south Indian regional hubs, such as Bangalore and Hyderabad. Callao as regional government (next to Lima) in Peru has developed close links with local governments in a regional spatial data infrastructure, in which information and knowledge is shared, and which allows local governments to introduce their priorities in developing further knowledge products for urban and regional planning. These results together suggest that regional hubs have the potential to develop hybrid arrangements both within their locality, and possibly to link up with state level organisations (if they are willing to deal with city governments) in spatial knowledge management.

In regional hubs, fewer NGOs are found with SKM expertise, which is also found to be fragile. They do have more links with the academic community, and interesting mapping processes with local communities were held within C2S. Such NGOs are better able to engage with local government organisations in advocacy processes than in capital cities. The main question is how such initiatives can be upscaled and more securely anchored in local urban development processes (Pfeffer et al. 2013).

In cities in larger agglomerations, such as Guarulhos and Kalyan Dombivli, strong leadership has been essential in driving the initiatives taken for SKM. Both are early innovators in ICT-GIS based initiatives led by government bureaucrats interested in improving quality of government, and basing local policy on better real time information. In KD, this was linked to ideas concerning better property tax and water billing management to obtain higher local revenues, speed up work processes in local government and reduce corruption, and in Guarulhos, it was linked to building environmental disaster prevention. Such efforts can have a wider effect, when they are rolled out to other local municipalities (such as is being done in Maharashtra with the help of KD), and can be limited to the overriding mandates of the large agglomeration (such as the prevention measures in SP which are negatively affecting Guarulhos). The need to further develop agglomeration efforts clearly comes out of the research results.

The presence of NGOs is these cities was found to be limited, and fragile – depending on one leader for maintaining a presence. Particularly when it concerns cities within large agglomerations, it is striking that the NGOs, which work within the dominant city, do not have a presence in the outlying areas of the agglomeration. Both Mumbai and SP are characterized by a variety of strong NGOS, which are yet not found in the other cities within the agglomeration.

Nevertheless, civil society and NGOs remain important in facilitating counter-mapping, notably on slum locations, large-scale projects involving population displacement (housing) and environmental issues. From our examples, it is difficult to weigh the influence of such interventions based on digitised participatory SK initiatives on, e.g. the orientation of slum politics, as they use a hybrid approach including more "classical" political and legal channels such as juridical contestation as well as the newer SKM platforms to influence existing policies.

6.3. Comparing outcomes: how does SKM influence domains in urban development?

In this section we examine the ways that SKM has influenced the strategic domains in urban development that we have identified in this research project – namely, economic growth (through mega-projects), the ways that cities deal with social inequalities and how sub-standard settlement communities mobilize around them, and environmental governance with a focus on water-related issues. Finally, we examine how SKM has been linked to fiscal decentralisation and more participatory forms of budgeting.

As we have seen in earlier sections, the extent to which ICT-GIS-based SKM has been introduced is quite variable, partial, and uneven across domains. Therefore, the conclusions we draw on the influence of SKM are concerned with the following questions;

- to what extent have discourses, framings become more inclusive and spatial?
- Have they become more inclusive in types of actors?
- to what extent have they changed work processes (efficiency, effectiveness)
- have they included different types of knowledge and participatory processes; built capacity for knowledge management
- how have they changed outcomes;
- by addressing new types of complexity, uncertainties, and stresses, and
    - by increasing transparency and accountability towards citizens
    - built capacity for knowledge management

6.3.1. SKM influences on megaproject development

In the cities studied, the city discourses and framings on economic growth through mega-projects have had a focus on combinations of projects rather than a total city visioning. These projects have more or less explicit spatial framings, depending on their focus (infrastructure, transport; housing; water infrastructure). Characteristic of the spatiality of city visioning is that such plans do not respect existing city limits, but cut across boundaries or existing planning limits set.

The actors involved in the mega-projects are the private sector, representatives of national governments, and regional authorities (Durban; SP region; Mumbai agglomeration, Chennai state), and mostly bypass local governments in developing their plans. This is done by following 'exceptional' processes and bypassing regular urban and regional planning processes, based on strategic motivations (with often hidden agendas as well). The visualizations of such projects often portray an urban reality, which ignores existing situations on the ground, especially where it concerns areas or populations not wanted in a pro-growth perspective (sub-standard settlements, small and medium-scale enterprises).

The kind of spatial knowledge, which is mobilized to prepare mega-projects concerns plot boundaries, land markets, land use and values, and zoning regulations. The private sector is the main driver in putting land packages together for future investors and redefining land uses in particular areas to make that possible (Chennai marshlands, Durban area north of the city). The lack of spatial knowledge in mega-projects is recognized by actors, who take steps to acquire such knowledge through their own private initiatives. Such knowledge is then kept within the companies generating them.

The type of knowledge included in mega-projects mainly concerns expert technical knowledge. Particularly where it concerns information about land markets and values, there is a lack of transparency generally speaking. In India attempts are being made to make this more transparent in an institutional manner, by putting contract tenders online for interested investors and citizens. Technical knowledge is presented as 'objective' knowledge to depoliticize decision-making; to avoid political influence. Knowledge on environmental and social impact assessments are usually part of a mega-project proposal, but there has been little evidence available on the extent to which these are produced in the cities included in the research project.

In mega-projects for housing, consultation processes with local communities are built in to the project through representatives of social movements or political parties (Cape Town, Salvador); however, this usually occurs only for allocation purposes, not for housing project design, so that community-embedded knowledge on needs and priorities is seldom included. Some counter-mapping concerning mega-projects has been found by local communities (Lima; Durban), but it remains difficult to negotiate strongly enough with the main mega-project actors to make major changes in the mega-project design and implementation.

SKM has influenced mega-projects as important strategies in urban development, by allowing proponents of such projects to promote a spatial imaginary, which ignores the complexities on the ground, and emphasizes the 'world-class' character of the results of such projects. The imaginary is oriented towards middle-class and elite quality of life issues, and usually bypasses issues of the poor and marginalized. In such mega-projects, the visioning has not included a variety of visions of other actors, but privileges the visions of private sector, and provincial and national levels of government. Only when social mobilisation takes place in a strongly organized fashion (N2Gateway project in Cape Town; Lima River Rimac project), are the voices of marginalized residents heard by the mega-project actors (Jacobs 2013).

In tracing the mapping done within such projects, analyses of the political choices that become embedded in the maps show the shifts in ideas and preferences, and can be compared over time (Durban, Delhi).

Where mega-projects contribute to building and expanding city infrastructure, it deals with existing stresses in a major way. The effects are often more directed towards issues the middle-class face, and the benefits are unequally distributed among social classes.

The use of SKM in mega-projects has not increased transparency and accountability towards citizens much, as both governments and private sector remain reluctant to allow much insight into the design and implementation processes, or to provide spatialized evidence on progress in the projects. The use of Google Earth by advocacy groups around mega-projects is a possibility, which is increasingly being used (Chennai). The use of internet-based social media generally provides the basis for greater transparency and accountability (e.g. Lima como vamos?), but is not necessarily linked to mega-projects only.

6.3.2. Implications of SKMC for upgrading and resettlement initiatives[76]

The majority of sub-standard (re)settlements (impacted by mega-projects) that were covered in our research project do not have spatialized discourses and framings, which have become more inclusive. The plans for resettlement are designed by the government agencies responsible (often within national programmes) and are shared mainly within the government agencies involved (in India). Although mandatory forms of consultation with beneficiaries and their political representatives exist in Brazil, Peru and South Africa, in these countries resettlement projects do not include consultation in the design stages (or these have been removed early on as in Cape Town). Recent programmes in India – RAY – are designed with much more extensive spatial framing in mind (based on ICT-GIS) and participatory processes, but preliminary results suggest that such participatory discourses laid down in the documents are not further reflected in the thinking of organisational staff, or implementation documents of the programme (Tammi 2014).

The resettlement projects have generally not become more inclusive in terms of the actors involved in the projects or the knowledge flows incorporated into the overall programmes. There are obstacles to knowledge flows, which have strong impacts on local communities' capacity to build and utilize their knowledge for mobilization.

First, there is very limited community access to information (basic knowledge) on city developments, with retention of information by both powerful actors and communities. Although there are public mandates to include communities in decision-making, powerful agents retain knowledge or only provide partial knowledge, while rules for allocations change during the process. Allocation lists, spatial plans and time frames are deliberately kept away from the public. Mistrust, rumours and uncertainty then prevails, preventing meaningful engagement.

Second, the timing of knowledge sharing is also an obstacle, as resettled communities are only included in the processes at a very late stage. This is token participation. It creates false expectations and a sense of disappointment, and can trigger resistance and lead to delays in speedy implementation.

76 The data in this section was drawn directly from: **A question of knowledge? Knowledge management and power in upgrading and resettlement initiatives**, *by David Jordhus-Lier with Véronique Dupont, Cathy Sutherland and Einar Braathen*

Third, the role of community knowledge brokers is important. Community representative engage with 'expert communities' (NGOs, universities, administrators and local state officials) they become privileged knowledge bearers and gain power. They also have the power to share knowledge with the community or to selected individuals in the community and they have the power to retain information. There is always somebody who speaks *on behalf of* somebody else. Once these representatives are entrusted responsibility for coordinating community responses, exchanging knowledge and distributing information and resources, power dynamics in local communities are irrevocably changed. Questionable people who use their role for personal benefit become illegitimate as they misuse knowledge and information.

However, several initiatives exist which show how generation of spatial community-based knowledge can take place, and how it can be utilized to build more participatory processes and change outcomes (in the sense of processes). In the C2S research project, such spatial knowledge building exercises were carried out in specific sub-standard settlements (Durban, Lima, Rio, Guarulhos?). Other similar initiatives were also found. Such initiatives, usually undertaken by the local community with actors and organisations from outside have built capacity for knowledge management as residents realized the extent of their knowledge about their local situation.

In several cases, the plans and maps built up through such processes have produced new information and knowledge. In Lima, they have produced maps of inequalities in water provision, and predictions about the effects of future shifts in climate change, population growth, and the resulting levels of water provision or water shortfall.

Community-built knowledge has been incorporated in local community negotiations with resettlement agencies (Durban). It also increased the knowledge residents had explicitly about their own settlements; bringing tacit knowledge into community-based processes and making it explicitly embedded. This increases transparency for citizens in particular areas, as they develop more agency vis-à-vis their living environment. It does not necessarily increase the accountability of government organisations, as this requires collective mobilisation by communities to make their knowledge be heard effectively.

In conclusion, spatial knowledge management provides the opportunity to support changing outcomes, although the circumstances have to be conducive to incorporating such community-embedded knowledge into processes linked to housing and resettlement projects.

6.3.3. Implications of SKM for urban water governance (WP4)

The various countries have shown shifts in their framings and discursive approaches to urban water governance, and water–related risk management. India previously had a public provision approach and now has a stronger sectoral approach, with increasing private sector provision to balance public sector gaps. In contrast, Brazil and Peru have watershed approaches, with water increasingly being seen as a human right. In South Africa water is seen as a human right, but limitations are set on the methodologies through which it is provided within cities and outside the city development lines. Similar limitations exist in India, which has differential rights to water for certain populations (in sub-standard settlements) – part of a 'democratic deficit'. Discourses have become more inclusive in terms of populations having rights to water and non-human rights related to sustainability of water aquifer systems. Since water management is inherently spatial, sustainability approaches have meant that watershed basin areas have become relatively more important, implying more recognition for spatial dimensions in contrast to approaches prioritizing universal water provision for urban populations.

Water-related risks are dealt with under 'disaster or flood-risk management', which comes under other departments than water in the cities concerned. The discourses in this area are moving from reactive to more preventive measures. Such ideas are driven by greater awareness after experiencing disasters as sudden shocks, and often pushed by civic organisations[IB1] . This means that where such risks are connected to water and sanitation systems or drainage systems (e.g. when improperly working sewerage and drainage systems cause flooding), ideas need to travel across organisational boundaries (Jameson 2014).

The main actor networks remain those of government, working together with the private sector. For drinking water provision, this ranges local and state government and often includes a combination of para-statals and private sector providers. For watershed management, provincial or national government departments dealing with (ground)water resources remain dominant actors in networks also including water committees with stakeholders involved. For flood risk management, the actor networks are much more dispersed (fragmented) (in Chennai), and have begun to work together more with civic organisations and local communities, both for training of and dissemination of knowledge to communities as in terms of consultation processes (Cape Town, Guarulhos and Lima). This means that such networks have become more inclusive in terms of types of actors, although the power of civic organisations to change basic ideas and influence work processes remains limited.

Technical information remains the dominant type of knowledge incorporated into drinking water provision, with a shift towards information systems that can link different kinds of information (Durban, Guarulhos, Delhi planned). This is true especially for investment in expanding water networks and for improving technical capacity of water systems (reducing leakages, etc.). Consulting companies play a major role in investment proposals on expanding water systems across the board in the cities concerned. The use of GIS within the parastatal companies is extensive in these processes, with strong in-house competencies being found in South African cities, in Guarulhos, Lima and to a lesser extent in Indian cities However, the consulting companies bring in GIS knowledge for preparing investment plans. Data collection for preparing plans and monitoring comes from various sources in the cities concerned, such as Census, state level data centres, and information produced by the water providers themselves. The way in which knowledge travels within the organisations concerned was found to be very limited in Chennai, where the knowledge on actual piped water networks was only found among street-level workers and was not codified elsewhere within the parastatal organisation. In KD, explicit links were made between various groups of experts to move the water project there forward.

More participatory networks including civic organisations are mainly used to train communities and disseminate government or private sector providers' knowledge that these organisations feel residents should have. In several cities, more interactive consultations were also held with a variety of stakeholders (Durban) and digital feedback systems from residents provide information on maintenance problems (grievances) in many of the cities studied. In most cities, NGOs working on water-related issues are the strong civic organisations in such processes (Lima, Cape Town, Delhi). Where participatory processes are mandatory, such as in Brazil and Peru, this strengthens the position of such NGOs. Residents of the city – when not organized – are not recognized as important knowledge providers for water-related issues.

Disasters such as floods have triggered more participatory processes to institutionalize measures against flooding, including the use of early warning systems for citizens through mobile phone and other digital systems, and institutionalization of spatial knowledge in government departments mainly focused on the coastal zone (Guarulhos; KD, Chennai, Lima, Delhi, (Durban, Cape Town). In Lima international research projects provided linkages that stimulated discussions around the topic of climate change and water-related risks in a wider network. Local leaders driving changes in government and civic organisations remain very strategic (Guarulhos, Cape Town, Lima, Delhi).

Scenario-building workshops held throughout the C2S project have served to bring together a variety of stakeholders and exchange different perspectives on the future of water availability and water risks and how to deal with the associated challenges.

Work processes have changed through the introduction of SKM, providing the basic information needed for internal management information systems for more efficient/ effective billing (in India and Guarulhos). The early warning systems are also examples of changed work processes, helping prevent disasters (Guarulhos, Chennai). These have made work processes more efficient certainly, and most likely more effective in terms of revenues collected (although for most cities insufficient info to say that).

SKM has contributed to changing outcomes, by allowing organisations (both governmental and civic) to improve their knowledge bases, and to make them more spatial in terms of taking scarcity and risk areas into account. This helps to address the complexity of water provision, and water-related risks, such as floods. It is also helpful when broadening the scope of water management to the watershed basin, where technical and spatial information on hydrology and physical features is usually collected by governments, in partnerships with private consultants.

SKM can potentially increase transparency and accountability to citizens and in some cities has already begun to be part of the regular exchange in consultation processes, and platforms with various stakeholders. What is not yet recognized is the importance of community-based knowledge, providing the micro-level knowledge on local water-related risks, and allocations of drinking water.

SKM has built capacity for knowledge management, by internal information systems used by drinking waster providers, government organisations dealing with ground and surface water management, and by addressing new types of complexity, uncertainties, and stresses, and among civic organisations, utilizing the spatial sources of information which have become more accessible (Google Earth).

6.3.4. Implications of SKM for fiscal flows and participatory budgeting

The link between SKM issues were not easy to locate in the research around local budgeting, as it is unusual in budgeting processes for spatial knowledge and tools such as maps to be specified as significant. The dominance of financial indicators in a traditional sense and distribution debates,

issues and contestations tend not to be referenced in terms of space by most actors. However, when pressed further, it did become clear that more and more spatial dimensions in budgeting processes were being noted – both in terms of tools used and in terms of discourses around distribution. This probably reflects a growing usage of spatial planning and related spatial information tools in local government and the resulting pressure to get budgets and space to interact – whether it be through representations of where spatial priorities are (for example in terms of infrastructure backlogs in Durban and Cape Town) or through mapping resources, assets and systems with varying degrees of financial significance (for example bulk water systems).

The most prominent recognized linkage between SKM and fiscal flows for local government (decentralization and participatory budgeting), lies in the ways that local governments generate and collect property taxes, which tend to constitute a major part of their budget. As reforms have taken hold in terms of decentralization and devolution growing pressures have been placed on local governments to generate revenues effectively. This has tended to place matters of property taxation – often a first port of call for revenue hungry local governments and reform hungry central governments – at the core of fiscal planning and management in cities and local government more generally. Since property taxes are generally supposed to reflect the relative values of different property categories (whether they be residential or commercial or value categories) the accessing of data about and analysis of property data has been of growing importance.

The role of SKM lies in the extent to which digitized databases have been built up for existing surveyed properties and the related property transactions and how they are used to determine levels of property taxes. Strategic is the ways in which such databases are linked to work processes by means of which property tax calculations are made, bills produced and money collected. The monitoring of the information going into the databases is also part of the SKMS, which can be done traditionally through on-site monitoring or through satellite image analysis (Durban, Cape Town, KD).

Discussions on these issues have been subsumed under the heading of efficiency (reducing time needed for property tax calculation and more standardized calculation, i.e. less corruption), as well reduced amount of time needed to collect taxes. It has also come under the heading of effectiveness in being able to collect taxes in reality, and being able to check more quickly which property owners have not paid. Being able to collect mandated taxes effectively is fairly essential for local governments to function properly, and to be able to finance collective service provision. In K-D tax revenues generated have doubled through the use of spatial knowledge management. In South Africa critical debates and policy frameworks have evolved in an attempt to generate a property tax system that has stronger redistributive elements where properties valued under a certain threshold of market prices are not required to pay property rates (taxes). This makes the capturing of this data a very powerful tool within the cities and it is also often the case that the categorization of the characteristics of different areas in property value terms also aligns with different service delivery and utility/service billing arrangements. Looking at the relationships between official and market valuations and the alignment of these to government organization can also be useful. For example the multiple municipal structures in a city such as Lima do not allow inter-municipal redistribution, whilst this is key in South Africa with its “one city, one tax base” framing of policy. Although other forms of transfers from central or state governments have generally been growing alongside sources of own revenue, the growing push for municipalities to fund enormous resource backlogs with loans or bond issues from other sources means that demonstrating own revenues streams is critical. In this regard it is no surprise that one could point to elements of city spatial plans as carrying signals of how cities plan to spend money and how they intend to raise revenue against these plans – by for instance opening up new areas for private property development that could secure property tax revenue streams.

The second linkage between SKM and fiscal flows for local government concerns the extent to which fiscal budgets and spending are linked to spatial locations rather than sectoral allocations. The main question is whether there is a move towards more strategic spatial planning and whether the ways that budgets are prepared, spent and monitored/adjusted reflects such a shift. Local government budgeting is usually done by Department, which reflects a sectoral approach. Some national programmes have started to direct local governments to prepare more integrated budgeting through their City Development Plans, which link projects from different departments to each other. In K-D this has been done by ‘adding up’ existing projects, with little attention to the spatial allocation of projects, i.e. there is no mapping.

In Durban the eThekwini Municipality has invested considerable time and effort to develop a range of spatialised forms of knowledge that can be used in fiscal management processes. These are most often used in relatively closed technical circles and with key political leadership to help guide decisions. For example the Cost Surface Model of the eThekwini Municipality provides spatialised data on the costs of delivering services to housing projects across the expanse of the city and has

been used to inform the adoption of the Urban Development Line and differentiated services. Furthermore, the city officials have used the ruling party's organizational districts to provide information on how funds have been and intend to be allocated so political leaders and bureaucrats can engage over the distributional consequences over space around the decisions. Efforts are being made to sophisticate the spatialised knowledge about these districts to include multiple layers such as articulated community needs, socio-economic indicators, existing service patterns and the like. This has been further encouraged through national grant funding which has very specific spatial targets.

The third linkage between SKM and fiscal flows for local government concerns the extent to which local area planning is carried out in Master planning processes, and how participatory the processes involved have become. This question relates to the ways in which land use planning takes place in the cities studied, and the extent of the commercialization of land markets in cities. One issue is what types of classifications of land use are recognized in land use planning, and the extent to which sub-standard settlement are or are not included in such classifications. In Chennai there is no classification for 'slum' in the land use categories.

A recent development is the extent to which Local Area Plans are being carried out within wider Master Plan/ Framework Plans, and how they incorporate participatory processes and spatial knowledge. In Delhi this process is going on and in Chennai it has also happened in the context of preparing the recent Master Plan, but it seems to be rather consultative rather than interactive, with the possibility of new input through citizens.

In Durban and Cape Town, the law requires a participatory process for the development of Local Area Plans, although this is not the case with Spatial Development Plans, which are developed by officials. In South African cities the spatial information demands are considerable as they are required to demonstrate a need for national grant funding sources – including for housing. Although SA has a very decentralised system – it has also used many conditional grant systems to require certain types of policy alignment and performance management of municipalities. So it is not simply enough to apply for generic water funds. One has to demonstrate exactly what it will be spent on where and what the system impacts will be. This requires some use of spatialised knowledge systems. First there is the need to have data across space with local accuracy (eg households with levels of access, or existing systems and their specifications – water pressure, network). Secondly this needs to be presented spatially to help make a case for the allocation of funds. Here it should be noted that external consultants – especially in engineering are in widespread use to help prepare these and, at least in Durban, there are quite good protocols about the data belonging to the municipality. However, these systems tend to be technically focused and not specifically generated for engagement with citizens are reflective of citizen views and knowledge.

The Brazil model – at least in some areas such as Gaurulhos – the emphasis is on decentralised community engagement processes and not necessarily on the spatial knowledge technical tools. In this sense community knowledge forms a key input to guide the technical whilst in Durban it can be the case that the technical is used to filter out community issues that might not meet some or other technical standard. In Guarulhos, the participatory budgeting processes at neighborhood level feeds into city-level plans, but there is no guarantee that neighborhood plans will not disappear in the larger plan. This is a more advanced model of participation, in which the allocation of some financial allocations is linked to discussions of what should be developed within the LAPs.

The interesting question about this linkage is the extent to which participatory processes allow issues to be determined within the local area so designated. In India, there is only consultation of issues that are on the agenda with limited possibilities for strategic new issues to be included or determined locally, whereas in South Africa and Brazil broader participation is possible and/or mandatory.

If we look at the way the private sector deals with land use planning, it concerns much more the issue how areas around the fringes of cities are 'developed' or drawn into the city through private sector development in these greenfield sites. We have seen this in Chennai in the IT corridor, in Durban through the development of the new airport and Dube Trade Port in the Northern corridor. In KD, private sector development has occurred in the area of the city, which was excised from the city in the 1980s. In Cape Town, there is a very large residential development proposed for the periphery of Cape Town outside the urban edge. This contentious proposal has been approved by the provincial authority and is being opposed by the municipality. It remains to be seen how this development will proceed against such opposition.

6.4. Conclusions

Finally, we ask the question of how the changes in SKMC link to the processes of building (adaptive) capacities in such a way that urban development becomes more sustainable towards the future.

The majority of our metropolitan cities are tending to grow – through combinations of commercial and private residential growth as well as through growth of sub-standard settlements. This growth has taken place largely outside the formally designated areas for urban development, with those areas later being incorporated and/or recognized by the city. This can be characterised as a sprawl growth model. This is happening despite municipal policies to make cities more compact and to prevent sprawl (such as the UDL in Durban), and has meant that there are great fiscal pressures to extend services to the urban periphery. These come both from a need to service the urban poor and from demands from private developers wanting to develop land and add value to it. Because of demands for infrastructure on the urban periphery it is necessary to help fund infrastructure through private development in the area too. This spatial conundrum is key to understanding sustainable development challenges in cities and is not easy to represent spatially despite the fact that it is such a key issue.

The cities' actor networks are dealing with new stresses and demands in local governance of urban development. The use of mega-projects for urban growth and development has meant that the way cities have grown has been both in line with local government policies as well in contention with such policies. They have shaped the cities concerned in focusing on large infrastructure, but also on building areas geared toward private investment and middle-class residential requirements. Boundaries of the cities concerned have changed because of such mega-project locations, pushed through despite local government policies.

The ways of dealing with sub-standard settlements include both evictions as well as resettlement through large-scale housing projects in the cities concerned. Mobilizing around such processes remains important and difficult for local communities; the use of mapping of local situations of communities is a new instrument which can be useful to establish their claims and entitlements.

Environmental governance of water-related risks, provision and climate change shows that water discourses are shifting towards water as a human right, and a recognition that its governance needs to include a water basin perspective to ensure long-term sustainability for urban water provision. Although this is much more prevalent in Brazil, South Africa and somewhat in Peru, in India this perspective remains limited to environmental activist organisations.

Spatial knowledge management configurations based on digitization and spatialization of knowledge sources (ICT-GIS-ed), are being built up throughout the cities concerned, within and across government departments, the private sector (real estate), and among NGOs and local communities. Characteristic is the uneven nature of such build up, and the 'stickiness' of standardizing the protocols of collecting and categorizing information, the lack of cooperation within and between organisations, which prevents knowledge from travelling – in strong contrast to the assumptions made in the 'assemblage' literature.

Knowledge configurations are built up by domain, and efforts to integrate them are rare to find. This implies that it will still require a great deal of reflexive thinking and interaction to integrate these strategic domains in order to make urban development policies more sustainable. i.e. to weigh the trade-offs of particular policies in relation to long-terms goals of sustainability.

However, it was encouraging to find that many and multi-sourced initiatives are taking place through which the necessary spatial knowledge is being acquired by citizens, developers and municipal officials in their attempts to plot a pragmatic path for urban development. These initiatives are supported in various places by more inclusive forms of budgeting and funding allocations through participatory processes. Up-scaling such processes holds the promise of building adaptive capacities through knowledge management and fiscal processes for dealing with future stresses and shocks, and moving cities in the direction of sustainable development in the long run, within a context of increasing complexity and uncertainty.

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