Understanding African Peri-Urban Landscapes Using Participatory GIS

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Using geospatial technologies for understanding the African urban environment is now becoming a reality. However, these applications have tended to focus on large cities. Consequently, peri-urban areas, one of the fastest growing, yet little understood sectors of Africa's cities are being excluded. Overwhelmed by rapid growth without a corresponding institutional and technical capacity, peri-urban governments find themselves unable to understand their own growth. In Eastern and Southern Africa, they have become hideouts for criminals due to the spontaneous population influx. Consequently, these areas have become new centers for economic distress and social despair. This paper explores a sustainable geospatial methodology that can help peri-urban local governments understand and cope with this rapid transformation. The paper employs a participatory GIS (PGIS) conceptual framework. The study involves building a GIS for Athi River town, a peri-urban community of Nairobi, Kenya. The Athi River GIS includes data on land cover, land use, hydrology, topography, social and physical infrastructure, industry, service provision, and housing. To augment the conventional GIS, community local knowledge is integrated as an information layer in the form of group mental mapping, focus group discussions, GPS-based transect walks, social histories of exclusion, oral narratives of land use, and relevant archival material. The study reveals that the integration of local knowledge and modern geospatial technologies in the context of a PGIS presents a valuable platform for the assemblage of spatial data for understanding rapidly growing yet data-poor peri-urban landscapes in Africa. The methodology is innovative, culturally sensitive, relatively inexpensive and locally sustainable.

Introduction

One in two people will live in cities in 2008, and by 2030, over 60% of the World population will live in cities – majority of the growth occurring in the developing World (UNFPA, 2007). At a period when the largest cities in the developing World are *spilling-over* into their peri-urban areas, future urbanization will be largely a peri-urban phenomenon. In Africa for example, this rapid urbanization rate in the periphery of its largest cities is taking place without a corresponding growth in institutional capacity within the respective local governments (Koti, 2006). In the circumstances, peri-urban local governments find themselves unable to manage or understand their own growth. The problem: too many people, too quickly. Consequently, these areas have become new centers for environmental degradation, social despair, economic distress, and escalating crime. The rapid transformation of peri-urban areas in Africa and their potential to become the new centers of Africa's urban population presents a new challenge: to explore new approaches for understanding peri-urban growth and sustainable ways to address the new challenges. The use of modern geospatial technologies is one among many approaches and will be discussed here.

Fortunately, using geospatial technologies for understanding the African urban environment is now becoming a reality. Most recent literature demonstrates a growing concern for mapping land use and land cover change, infrastructure inventory, transportation planning, environmental management, decision making and other location-based uses (Anderson, 2000; Jiang and Eastman, 1999; Koti, 2004; Mwatelah, 2001, NRC, 2002; Taylor, 2004). While the use of geospatial technologies in African urban environments are becoming a reality, so too is the absence of the technical expertise and the necessary infrastructure in the often data-poor lower levels of local government. In Eastern Africa, for instance, the creation of urban geospatial databases has tended to reside in the central government, large municipalities, local and international research institutions, and donor funded and individual projects. In these practices, the locus of attention has been the observable and quantifiable aspects of the urban built environment of large cities such as Nairobi, Mombasa, and Dar es Salaam to name but a few. Overwhelmed by rapid growth induced by proximity to a large metropolitan center - without a corresponding growth in infrastructure and resource base, peri-urban communities face new challenges every day. Furthermore, the experiences of local

communities in these areas have remained peripheral in policy debates and digital spatial databases. As a result, the understanding of peri-urban growth is taking place in the context of traditional urbanism thought, top-down and change-driven.

This paper employs a participatory GIS (PGIS) approach within the broader GIS and Society conceptual framework to examine how the integration of community local knowledge can help populate urban-based geospatial databases for a more robust understanding of African peri-urban landscapes. Specifically, the paper seeks to shed light to four broad research questions. **First,** what are the potential limitations within traditional conceptualizations of African peri-urbanization and how is the introduction of GIS in African urban research impacting this understanding? This question emerges against a backdrop of an apparent ambiguity in the literature over the terms of reference, scale and scope of engagement regarding African peri-urbanization. Contemporary literature on the subject portrays a concern for understanding the physical changes taking place in these fringe landscapes, strategies of survival including farming and other informal activities, and various efforts by the civil society to bring these areas within modern urban character and standards (Baker, 2002; Browder and Bohland, 1995; Briggs and Mwamfupe, 1999; Friedberg, 2001; Gough and Yankson, 2000; Mbiba and Huchzermeyer, 2002). Furthermore, the authors also assume that the rapid adoption and proliferation of GIS in the African continent in the past two decades has the potential to influence and shape the way in which society views, values and uses spatial information. In the process, the introduction of GIS in African urban research could further impact this understanding of peri-urban development.

Second, we seek to identify the challenges posed by the rapid transformation of African peri-urban landscapes and further explore the potential for geospatial technologies to address these challenges. The authors assume that while GIS offers excellent ways of capturing, analyzing and representing directly observable phenomena, the technologies may nonetheless be limited in addressing the cultural, historical and experiential components of everyday life, typical of most non-western societies. Specifically, the use of GIS can exclude the perceptions and life experiences of disenfranchised (peri) urban communities, who are mostly impacted by decisions made based on these spatial databases (Dunn, 2007; Harris and Weiner, 1998). Against this background, the authors identify the potential limitations of geospatial information technologies in certain social contexts, Africa in particular.

In the **third question** we explore locally sustainable approaches for understanding African peri-urban landscapes. Specifically, we ask: How might participatory GIS enhance local capacity to understand and address the new challenges posed by spontaneous growth especially in data-poor peri-urban environments in Africa? To present a more complete and representative urban geography of these areas, the paper employs a GIS and Society approach to integrate local community perceptions of peri-urbanization into a GIS for a more robust and place-based understanding of quality of life in Athi River town, Kenya. **Finally**, the authors endeavor to understand whether community local knowledge and expert geospatial data for peri-urban residential development are complementary or contradictory.

A Peripheral View of African Peri-Urbanization

African population that resides in areas categorized as peri-urban has increased steadily in the past two decades. Browder and Bohland (1995) observe that approximately 42% of the Third World's total urban population lived in informal settlements two decades ago. A study conducted by the UNCHS notes that 30% of these informal settlements are located in the urban fringe (Baker 2002). In the literature, these fringe

settlements have been variously referred to as: zones of spatial contact, agglomerations of poverty, metropolitan villages, belts of misery, and slums of despair (Browder and Bohland, 1995); African urban garden belts (Friedberg, 2001); expanded agricultural areas (Briggs and Mwamfupe, 1999; Freeman, 1991); spontaneous settlements, squatter settlements (Memon, 1982); dormitory towns (Rambanapasi, 1994) and sinks for the city waste (*Birley and Lock, 1998* cited in Koti, 2004). Seemingly, peri-urban settlements present one of the most challenging arenas of policy intervention in the 20th Century (ibid). Apparently, these locations still remain less studied, yet the most misunderstood part of Africa's cities (Baker, 2002; Gough and Yankson, 2000; Memon, 1982).

Four broad themes emerging from the literature on African peri-urbanization can be identified, including: 1) a concern with the importance of agriculture for the economic viability of these areas (Briggs and Mwamfupe, 1999 (Tanzania); Memon and Lee-Smith, 1993 (Kenya); Gefu, 1992 (Nigeria); Maxwell, 1995 (Uganda); Mbiba, 1994 (Zimbabwe); Rakodi, 1988 (Zambia); and Rogerson, 1993 (South Africa). 2) production and reproduction processes, the space economy and the importance of the informal economy (Memon and Lee-Smith, 1993); 3) development dynamics, land markets and the tenuous nature of property ownership (Gough and Yankson, 2000; and 4) the demographic processes responsible for and shifts resulting from fringe development and the effects of World Bank/IMF sponsored Structural Adjustment Policies (Briggs and Yeboah, 2001; Browder and Bohland, 1995).

From these themes, it is apparent that there have been relatively few in-depth accounts of how these fringe communities have evolved, and survive as well as their social life. More specifically, detailed analyses of how their spaces are represented are still inadequate. Consequently, as Baker (2002) points out, their conceptualization has been 'muddled by disagreement over the terms of engagement.' As the author (Baker, 2002) concludes, a missing component in these discourses, is a meaningful debate of the social dynamics of these settlements. [1]Supporting this argument, Mbiba and Huchzermeyer (2002:114) note that "…not only is there conflicting conceptualization of what peri-urban is, or should be, but there are also conflicting views on the nature and meaning of the processes taking place there."

As depicted in the literature, until the mid-1990s, with notable exceptions (such as *Mortimore, 1975 and Swindell, 1988* cited in Briggs and Mwamfupe, 1999) interest in these towns outside Africa's largest cities had been minimal. Where and when peri-urban areas have been discussed, they have been represented from economic and political perspectives, as zones of economic survival for the growing and increasingly hardly-pressed urban populations of the continent (Browder and Bohland, 1995; Memon, 1982). Apparently, there is no logical reason for the limited interest in and engagement of this otherwise crucial component of the city economy and social life in contemporary urban discourse.

The limited interest in peri-urban research prior to the 1990s, according to many (Baker, 2002; Briggs and Mwamfupe, 1999; Memon and Lee-Smith, 1993), can be attributed to several reasons: 1) A preoccupation with the seemingly more urgent problems of the burgeoning cities such as unemployment, underemployment, crime, pollution, congestion, housing shortages, spontaneous settlements and food supply issues; 2) An apparent lack of economic or cultural interest between the urban and the adjoining populations as the former came from distant places; and 3) Limited economic and social contacts between the cities and their hinterlands arguably because the cities were colonial creations and so they served external linkages to the metropole other than their own domestic hinterlands. Nonetheless, there is no sufficient explanation for this

[1] …The social life of peri-urban locations has remained peripheral in most of these contemporary discourses. What you find is analysis of patterns of change, mainly resulting from encroachment from an adjacent city… as reflected in the terminology, the field of research has been conceptualized in terms of what these areas presumably not…and have assumed that their work is to introduce dynamics by which to bring such areas more closely into line with conventional urban development…Very few have undertaken the fine-grained historical and analytical work that is required to understand the social, economic and political processes by which such communities have evolved and operate (Baker, 2002:8).

apparent lack of concern for the social dynamics of peri-urban development. Perhaps, the answer lies in the way these areas have been conceptualized in traditional urbanism.

Traditional Conceptualizations of African Peri-Urbanization and their Critiques

To better understand African peri-urban landscape, it is imperative to trace the conceptual framework under which these areas have been defined in the literature. Three scales of analysis can be drawn from existing work. First, African peri-urbanization has been portrayed in organic terms – as an outgrowth of the primate city in response to the inability to cope with soaring urban population. According to this organic scale of analysis, the peri-urban zone develops within proximity to and maintains close ties with the central city with majority of its population still dependent on the latter for their livelihood. These settlements typically have no separate administration, hence, still dependent on the city government for planning purposes and delivery of social services. The term spontaneous settlement has been used in reference to such settlements (Baker, 2002; Mwatha, 1979; UNCHS Habitat, 2001). However, more often than not, these peri-urban settlements within close proximity to the main city have been overtaken by outgrowth of the Central Business District and the general expansion of the cities and are no longer in the peripheral zone, but very much within the main city. For example, what was 'peri-urban' in the City of Nairobi, Kenya in the 1970's could as well be regarded as being subsumed into the central city as the elastic ring that defines the fringe continues to expand.

African peri-urbanization has also been conceptualized from a "transitional zone" standpoint. In this conceptualization, the landscape is considered to be highly transitional, in nature reflecting a multiplicity of land uses that progressively become rural as one moves from the urban center (Browder and Bohland, 1995; Mbiba and Huchzermeyer, 2002). In this scale of analysis, three typologies can be developed that define this transitional zone: 1) Peri-urban areas are viewed as zones of survival for the urban poor who engage in informal employment, usually agriculture, for their survival. This view of urban diseconomies is also supported by another, in which it is argued that rapid metropolitan growth gradually engulfs previously rural farmlands and villages. In this case, the essential functional character remains rural, but jurisdictionally within city or municipal government (Briggs and Mwamfupe, 1999; Freidberg, 2001; Mulenga, 1995). 2) Some commentators have also viewed these areas from a "suburbanization standpoint" where cost of land and the relative distance from the main city have been their defining characteristic.

Owing to the relatively cheap land, these areas attract industrial and commercial entrepreneurship as well as long time city dwellers seeking cheap rent and land, with some, mainly middle class, escaping the congestion of the central cities. The peri-urban zones thus become bedroom communities for the central cities (Briggs and Mwamfupe, 1999; Rambanapasi, 1994), arenas of investment and vibrant economies sometimes almost independent of the main city except for planning purposes (Browder and Bohland, 1995; Gough and Yankson, 2000). 3) Finally, is the step-wise migration view, where rural migrants move into the peri-urban zone as one step in a progressive rural-urban migration, creating what Browder and Bohland (1995) calls "a transitional social space or a temporary holding location for newcomers to the metropolitan center." As can be seen from this 'transitional lens', the fringe landscape is characterized by a diversity of land uses, which are often thought to vary in relation to their functional linkage to urban and rural areas. The inherent limitation within this characterization of peri-urban areas however, is that it assumes that all peri-urban locations are contiguous with the main cities and within their administration. However, in spite of the functional linkage to the metropolitan centers, some satellite towns are physically far removed from the immediate boundary of the metropolitan center as well as its administration and are economically independent.

The third conceptual view draws from the deliberate attempt by many African governments to devolve power and deconcentrate economic activities from central cities to secondary towns in a process known as decentralization (*Kiamba, 1994* cited in Koti, 2000). As a result, towns on the periphery of or adjacent to metropolitan centers become recipients of industrial and commercial activities, which in turn attract population and other social functions. These peri-urban towns have their separate governments from the adjacent metropolitan center even though they may house a significant proportion of the latter's population.

This understanding is however, complicated by the fact that some peri-urban towns have grown large enough to have their own peri-urban zones, which further obscures the scale of analysis for peri-urban growth dynamics.

Studies that have focused on development of settlements in the fringe have therefore drawn from this conceptual framework to analyze peri-urban development from economic and political perspectives. Macoloo (1987) identified three main standpoints from which these largely informal settlements are viewed: a problem perspective; a solution perspective; and a critical evaluation standpoint. The problem perspective views these informal settlements as blockages to development as they are considered to be "…spatially, economically, socially, and politically marginal." (Macoloo, 1987:6). In this hostile and indifferent view, most peri-urban residents are portrayed as misfits, and their settlements as cancerous outgrowths blemishing the city owing to their non-conformity to conventional urban standards (ibid).

The solution perspective, which advocates for institutional incorporation of these peri-urban areas is a more positive one and even offers solution for housing low-income residents. This view, which is based on economic growth, advocates for progressive improvement of these areas by their own residents with government support. The final perspective is the project evaluation debate, which calls for a critical evaluation and reformulation of the concept of 'self-help' in the peri-urban areas. What these perspectives leave out however, is the fact that these zones are economically exploited, socially ignored, and politically repressed. This notion is further amplified by Baker (2002) in her historical analysis of the development of Manyatta, a community in the fringe of Kisumu town, Kenya. Furthermore, the scales of analysis tend to focus on the physical aspects of development at the expense of the lived experiences of these often marginalized communities.

Conventional GIS Approaches

Geographic information systems are computerized systems which capture, store, manipulate, transform, retrieve at will, analyze, and display many forms of data, which are spatially referenced (Clarke, 1999). As used here, GIS offers an appropriate platform on which spatially referenced data are assembled, visualized, analyzed and represented. The last two decades have seen notable progress in the adoption and practice of the technology for various uses in the African continent. The main areas of focus have been natural resource mapping and management, transportation planning, urban and regional planning, academic research and private sector uses (Conitz, 2000; Hastings and Clark, 1991; Taylor, 2004).

In African geographic research, GIS applications are also contributing significantly to participatory planning and research as well as urban, environmental, population, climatic, land use, and natural resource management studies (Kyem, 1999; NRC, 2002; Ottichilo et al. 2002; Wafula, 1994). As a tool for measuring change, GIS is also enhancing African urban studies and research. More specifically, the technologies tend to offer more potential for analyzing the rapid expansion of Africa's primate cities and the subsequent spillover of population, commerce, and industry into adjacent peri-urban spaces (Anderson, 2000; Lupton and Mather, 1996; Perrin, 1990). The integration of GIS with other geospatial information technologies such as remote sensing and global positioning systems (GPS), as practiced in the developed world, also seems to offer significant potential for more innovative research (NRC, 2002).

For peri-urban research for instance, these technologies have been useful in the identification, measurement and description of spatial patterns and change, leading to a more informed understanding of urban growth in the fringe, hence widening the scope of geographic inquiry (Anderson, 2000; Gichuhi, 2002; Treitz et al. 1992). Unfortunately, GIS representations of these rapidly transforming African urban spaces have continued to reflect directly observable impacts of urbanization as perceived from social or environmental scientists' perspectives (Lupton and Mather, 1996; Perrin, 1990; Snel, 1993; Wafula, 1994). Consequently, many

historical and cultural experiences of local communities impacted by this transformation are being excluded. Examples drawn from Kenya for instance, demonstrate highly positivist and technicist approaches employed in analyzing urban development and change, to the extent that GIS practice is invariably an expert system, hence inaccessible to ordinary citizens (Koti, 2004). This situation offers ample potential for fundamental GIS and society questions relating to knowledge creation and access, representation, and resource allocation and use.

GIS and Society

International and locally based research using a GIS and Society approach is a recent and innovative field of geographic inquiry that has gained currency in the US and Europe. This approach has stemmed from a debate in Geography in the 1990s between social theorists and traditional GIS practitioners over the epistemological, methodological, historical, theoretical, societal, and ontological aspects of geographic information systems (Pickles, 1999; Sheppard et al. 1999; Taylor and Overton, 1991). In this critique GIS is accused of lacking a firm theoretical and philosophical grounding to earn itself recognition as a discipline, while at the same time, its way of creating geographic knowledge is seen to be elitist, top-down, and privileged towards expert knowledge (Pickles, 1999). CiGIS, the methodological approach applied here, falls within this larger GIS and Society framework and seeks to widen geographic knowledge creation through integrating community perceptions of their environment as an information layer in spatial databases used for decision-making in a non-western setting.

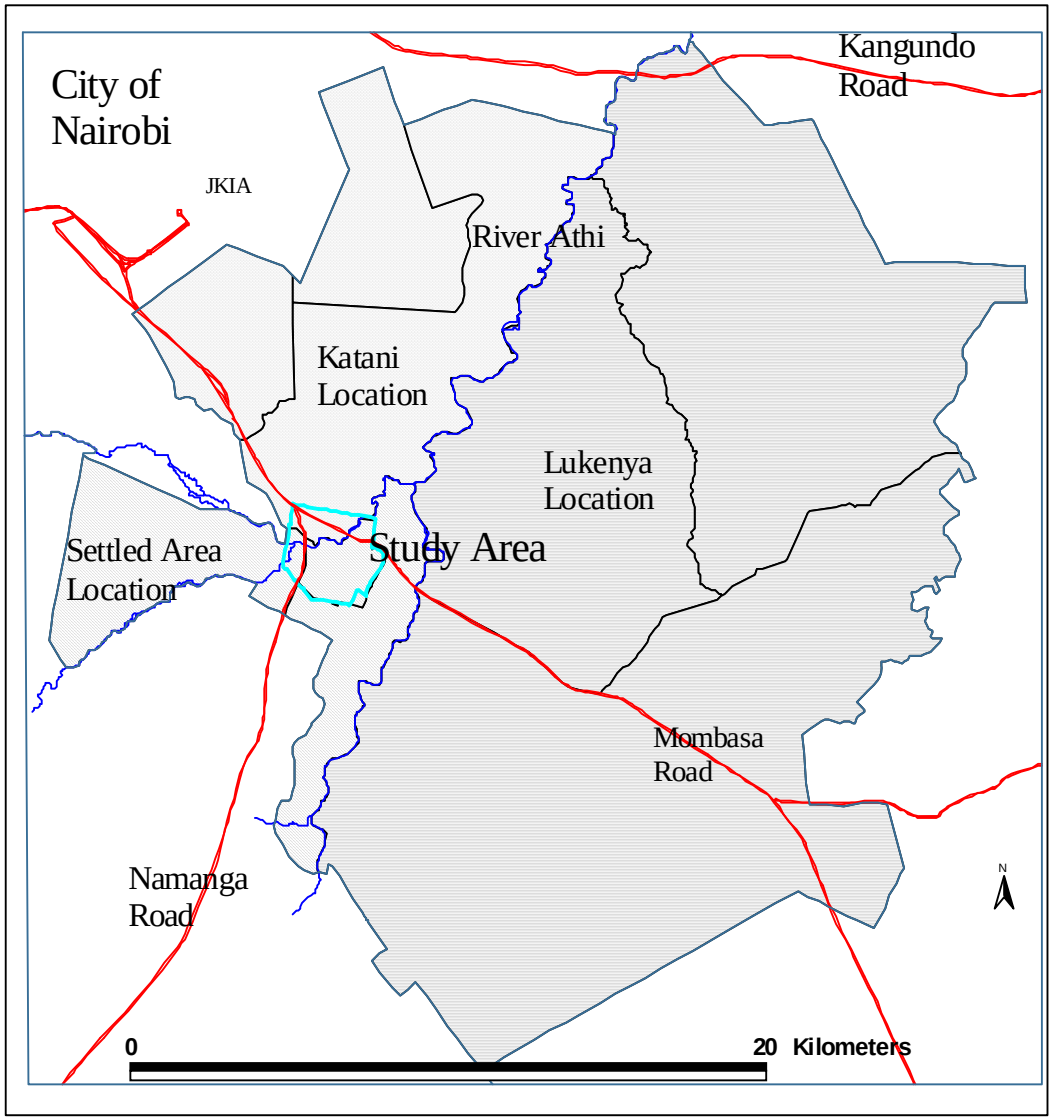
GIS and Society methodological approaches build on traditional public participation methods within a GIS environment to create in-depth knowledge of place, while overcoming certain limitations inherent in conventional GIS practice. PPGIS methodologies on the other hand draw from mainstream participatory research and planning frameworks (Weiner et al. 2002), and are intended to, among other things, increase public involvement in matters that impact their (citizens) lives including building knowledge bases about themselves within a GIS environment. An underlying assumption that besets PPGIS approaches is well captured by Weiner et al. (2002)[2]. As a result, the nature of public participation in the process can be contentious. The broader PPGIS approach situates GIS analytical tools within an expanded framework of communication where opportunities are opened for citizens to participate in problem identification and resolution, as well as data production and analysis (Obermeyer, 1998). Within this framework, it is assumed that the public controls and owns the system.

CiGIS, the methodological approach employed here embraces this broader PPGIS notion. However, within this framework, the agency or the expert assumes the system design, use and ownership (Harris and Weiner, 1998). It assumes that communities are socially differentiated, and as a result, differential access to resources may simultaneously empower and marginalize community members. Consequently, the socially marginalized may never have an opportunity to participate in, or own the GIS as often assumed in the PPGIS conceptual definition. The CiGIS methodology acknowledges this social and political reality, and thus employs an expanded framework that accommodates such disenfranchised members of society. As a result, local community perceptions and experiences are integrated into an expert-designed and operated GIS as mental maps, oral narratives and social histories (Harris and Weiner, 1998). More recent debates on the social aspects of GIS practice, have called for the integration of local community perceptions into traditional GIS databases. Despite variations in terms of reference, these approaches have been collectively referred to as participatory geographic information systems (Dunn, 2007; Weiner et al. 2002). The methodology employed in this study thus links modern geospatial information technologies including GIS and remote sensing with traditional public participatory methods. Specifically, perceptions and experiences of local communities are integrated into a traditional GIS database as layers of information to build an in-depth understanding of uneven development in Athi River town.

[2] …community-based GIS projects simultaneously promote the empowerment and marginalization of socially differentiated communities (Weiner et al. 2002:4).

Athi River Town Case Study and Methodology

Athi River town is located along Nairobi-Mombasa road approximately 30 kilometers Southeast of Nairobi, Kenya's Capital City (see Study Area in light blue in Figure 1). This town, which formed the nucleus of a small township forty years ago, has undergone tremendous socio-economic and spatial change. For example, its boundaries have been extended to encompass an expansive 693 square kilometers and a population of approximately 60,000 (2002 estimates) compared to the 8.5 (approximately) square kilometers of area and a population of 5,000 in 1969 (Koti, 2000; Okatcha, 1979). This expansive area is under the jurisdiction of the Mavoko Municipal Council and also corresponds to Athi River Division, a political administrative unit of the provincial administration. The spatial extent of the study is, however, limited to the area coinciding with the physical planning (settled) areas of the town (see Figure 1). Although the study area does not necessarily correspond to any particular administrative division, it is confined mainly within the Settled Area location, which represents an outgrowth of the original Athi River Township (see Figure 1).



JKIA – Jomo Kenyatta International Airport

Figure 1: Administrative locations of Athi River Division in Machakos District.

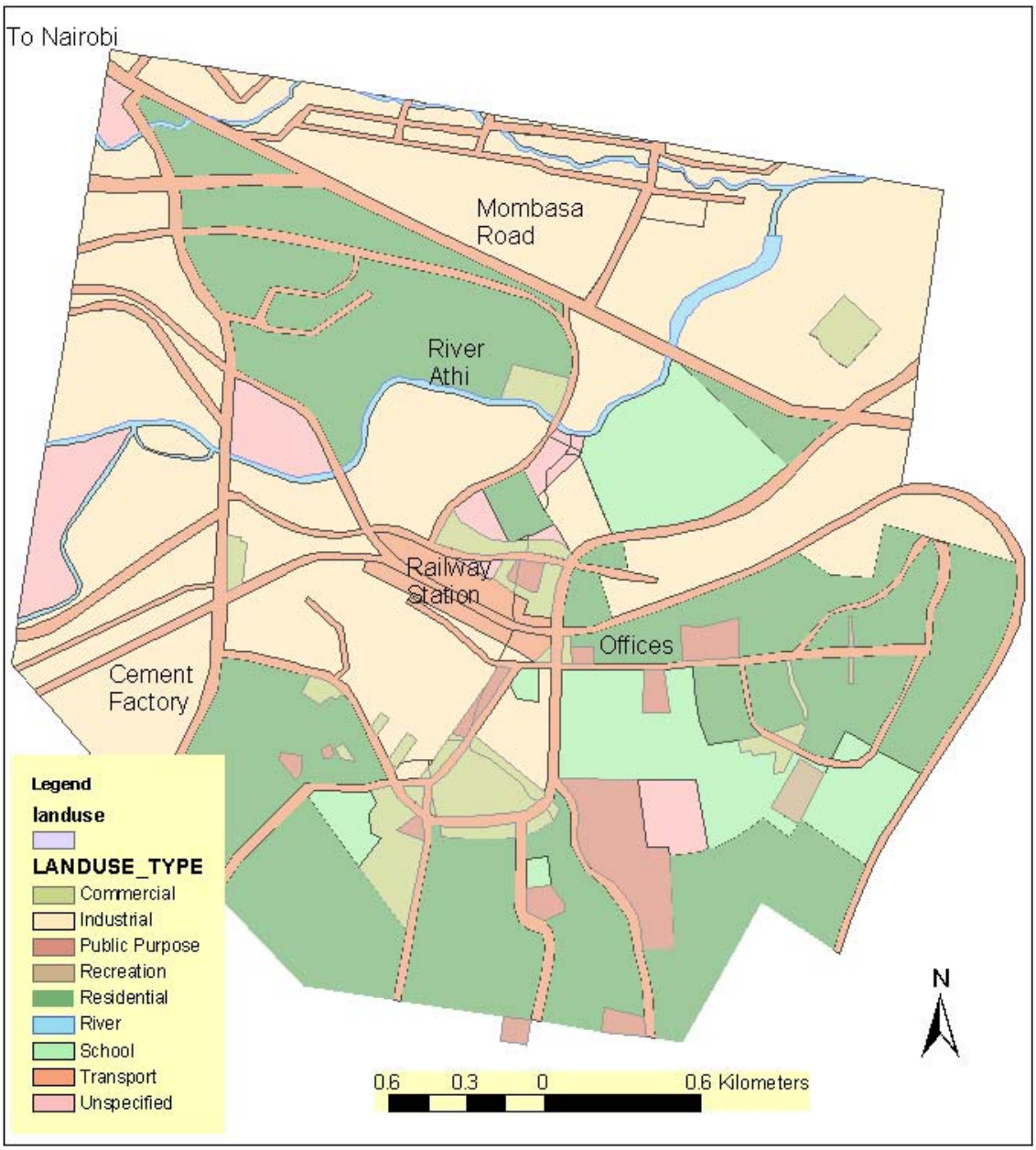


Figure 2: A 2002 Athi River town land use map

Athi River town lies in the heart of the low-lying Kapiti plains to the Southeast of Nairobi with an elevation of approximately 1600m. Her space economy, according to Koti (2004) is dominated by the activities of limestone mining companies as well as Export Processing Zones. As a result, the three dominant land uses are industrial, commercial and residential (see Figure 2). The economic and social set up of the town is diverse and complex. Lying on the peri-urban area of Nairobi, Athi River houses a mixed population comprising rural communities and urbanites. Within the rural category are pastoral and agricultural communities, predominantly Kamba in ethnicity, but also with significant traces of Maasai pastoralists. The urban cadre comprises impoverished slum dwellers that provide labor to the rapidly growing industrial sector, a commuting working class, and a fairly wealthy community mainly gravitating from nearby Nairobi City. This complex demographic composition poses serious planning challenges for the local authority owing to the

divergent interests and aspirations among the town's populace. As a result, the prevailing demographic and economic dynamics have created a spatially and socially differentiated urban environment.

According to the Mavoko Municipal Council Infrastructure stock assessment report for 2002, the town is host to over 8000 residential and commercial built up structures. Of these, over 65% of the housing stock is semi-permanent and/or lacks basic facilities such as sewer and running water. Moreover, the town's land use map (Figure 2) also shows that the classified roads mainly serve the town center and some emerging middle to high social status residential areas, while low social status neighborhoods in the periphery remain inaccessible. Simply put, the town exhibits social and spatial disparities among its population. To present a more robust picture of the unevenness of the residential spaces, a community integrated GIS methodology is employed in the context of participatory GIS.

Methodology

The methodological approach employed in this paper drew data from both quantitative and qualitative methods namely, GIS and remote sensing techniques, individual interviews, focus group discussions, participatory mental mapping, participant observation, GPS transect walks, and content analysis. The study involved building an Athi River GIS for analyzing uneven residential development. For the purpose of the study, residential development was defined to reflect the quality of life in a neighborhood based on: state of physical and social infrastructure; environmental vulnerability, condition and type of housing; and, the quality of delivery of social services and amenities to the extent that opportunities are created for the realization of human personality (Koti, 2004; Ngau, 1979). To better identify unevenness in residential development, a cartographic model was built reflecting the six standard measures of quality of neighborhoods. These include environmental vulnerability, accessibility by paved roads, nature and type of housing, housing densities, access to electricity supply, and access to social amenities and delivery of social services. Data on sewer and water was unavailable, hence not included in the analysis. The data deficiency created by the absence of reliable water and sewer information was however, met by use of field-based participatory methods. From this GIS analysis, environmentally vulnerable areas, physically inaccessible areas, high density neighborhoods, areas without access to electricity and other social amenities, as well as neighborhoods with a high incidence of low social status housing were identified within a GIS environment. These were also found to overwhelmingly coincide with low social status neighborhoods in the town.

The above analysis demonstrates that GIS offers a powerful way of analyzing and representing uneven development of peri-urban places by visualizing, measuring and quantifying various aspects of land use. The authors however, note that there are particular social contexts and aspects of social living in non-western cultures (and some Western also), which may not be easily measurable, and whose value and utility may not be immediately determined in quantitative terms. For example, one can ask: how might GIS represent historically cultural areas, ethnic tensions, histories of exclusion, high crime areas and informal recreation facilities which are common aspects of social living in most non-Western cultures? Furthermore, GIS has a tendency to homogenize residential areas as a silent category of land use excluding the internal characteristics within particular residential spaces. The authors also note that GIS analysis may also be limited in demystifying the social and political context of uneven development, unveiling social meanings, and confronting social and political realities that typify urban landscapes in most developing nations. To overcome these technological inadequacies, fieldwork-based community local knowledge in the form of oral narratives of historically cultural areas, social histories of exclusion, mental maps of forced removals, and focus group discussions on various aspects of resource access and use are integrated into the GIS as a local knowledge information layer.

Summary of Findings and Conclusion

Earlier in this paper, the authors identified an apparent flaw in the traditional conceptualization of African peri-urbanization. Approaches used to represent these fringe landscapes were also found to be positivist and empiricist in their methodological and epistemological orientation. The advent of GIS practice in the continent is also situated within this methodological and epistemological framework which largely embraces the analytical tools of traditional science. For example, the results of the GIS analysis (above) show that GIS analytical capabilities allow for the assemblage of different datasets for the analysis of spatial and social disparities in an environment characterized by information gaps. Through the GIS analysis of uneven residential development in Athi River town, housing size and status and average housing densities for residential neighborhoods are used to determine the social status of different neighborhoods. It is visually and analytically determined that a high incidence of low social status housing and high average housing densities are an indicator of social marginalization and differentiation in peri-urban communities such as Athi River town.

In this GIS analysis, social status is linked to access to resources in the town. For example, using GIS analytical capabilities, differential access to paved roads, power, and social infrastructure are identified, and further linked to the neighborhood's social status. In the same analysis, environmentally vulnerable areas are identified and analyzed. The authors however, argue that physical proximity to power lines only carries the potential to have access to electricity but actual access to power is a function of many other social and political processes. This could include (but are not limited to) affordability, connectivity, usability, and other social relations on the ground. It was further revealed that uneven residential development is more than the inventory of social infrastructure, and whether these facilities are in usable condition is a function of the social status of the neighborhood or underlying power relations. In a nutshell, this study concludes that by assembling municipal data and different forms of topographic data within a GIS environment, it is possible to determine and categorize the quality of residential neighborhoods in a peri-urban environment. It is therefore concluded that GIS offers an excellent platform to analyze uneven residential development in a data-poor peri-urban location. However, the technology is limited in its capabilities to represent the underlying social relations, which drive social and spatial processes across the urban landscape.

The inadequacies inherent within GIS analysis are overcome by integrating community local knowledge within the GIS as an information layer. Using a community-integrated geographic information systems methodological approach, the research findings show that there is a strong link between resource access and social status. As revealed by oral narratives and focus group discussions, resource access and use is impacted by social status. This further reflects in the neighborhoods where low social status neighborhoods are limited to what they can have or use. The oral narratives also revealed that efficient delivery of social services by the municipal council is a preserve for what participants call "upper scale" people.

Through an analysis of oral narratives and group discussions, it was revealed that peri-urban communities are diverse and complex. Their understanding thus requires a detailed analysis of underlying political and social processes which produce the built environment. Using the CiGIS concept, qualitative information drawn from local communities in Athi River town was analyzed and input in the GIS environment. The results show that although local knowledge can be problematic, it brings into a GIS the lived and experiential component of place, otherwise unachievable in conventional GIS practice. The authors therefore argue that there are certain forms of qualitative information drawn from community local knowledge that a CiGIS presents for the analysis of uneven residential development that traditional GIS does not. These include social histories of exclusion, forced removals, local land use conflicts and other forms of spatial contestation, historically cultural areas, oral narratives of land use change, local politics and other underlying social relations, which

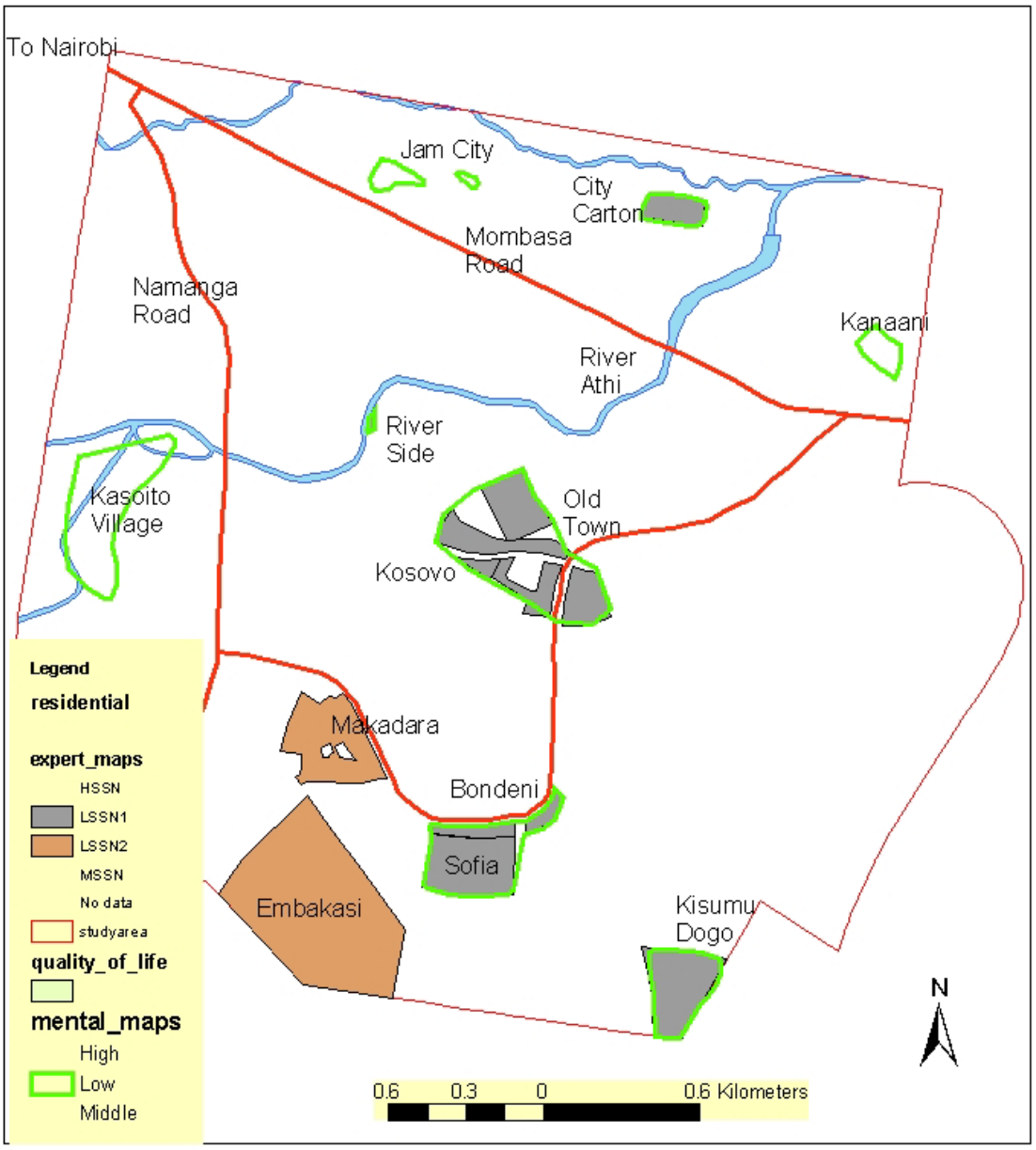


Figure 3: Local community mental maps of relatively low quality of life neighborhoods in Athi River town contrasted with expert knowledge of low social status neighborhoods

drive land access and use. In this way, a CiGIS contributes to understanding the intricate causal spatial and social interrelationships between land use and political and economic processes prevalent in peri-urban towns in Kenya, often unattainable in a conventional GIS environment.

This study was conducted in a peri-urban environment typified by information gaps. For instance, household level data on sewer and water connectivity was missing. Through focus group discussions and oral interviews, it was possible to determine reliability of water supply at a neighborhood level scale. A CiGIS thus presents on-the-ground realities and also verifies expert information about resource availability and usability. For example, using a distance buffer from main power lines, a GIS demonstrated that City Carton neighborhood

to the northeast of the town had access to electricity. However, focus group discussions revealed that there has never been any power connectivity in the neighborhood despite the network of cables above their roofs.

The complementarities of community-integrated GIS and traditional GIS methodologies were a key finding in this study (Figure 3). Although GIS technology was found to be a suitable platform analyzing and representing spatial phenomena, it was also found to be contradictory – with a tendency to simultaneously empower and marginalize people. It is therefore argued in this paper that there is a tendency to rely on expert knowledge when it comes to determining the condition of the urban built environment, while perceptions of often-marginalized fringe communities, who may not subscribe to modern urban standards remains peripheral to these conventional spatial databases. Furthermore, most conventional GIS are based on expert knowledge. In this case, it is more skewed towards visualization and quantification as it employs the principles of traditional science to analyze and represent spatial phenomena. In the process, the system empowers the expert on one hand, and on the other marginalizes local communities in the periphery of power.

The paper also shows that community local knowledge within a GIS unveils internal differences and lived experiences as well as social relations that produce these often spatially and socially differentiated landscapes. As a result, neighborhoods represented as bearing similar characteristics in terms of resource access and use based on physical proximity to resources in a GIS turn out to be different in reality. For instance, knowledge on the usability, connectivity, and regularity of use of sewer lines, water lines, electricity supply and other social amenities resides in the communities that use them on a daily basis. Oblivious of these internal differences and on-the-ground realities in certain cultural contexts, a traditional GIS spatially visualizes and represents these fringe communities as sharing the same place (physically), yet, internally; they live in completely different worlds (socially). Integrating community local knowledge within a GIS environment in the context of participatory GIS serves to augment the latter by presenting this on-the-ground reality in an otherwise data-poor environment which would have gone unrepresented in a GIS (in that particular setting).

The authors in this paper find participatory GIS approaches to be appropriate and more robust in representing various aspects of neighborhood character in peri-urban communities in Africa. More importantly, these approaches are found to complement traditional GIS through the integration of community local knowledge as an information layer. The methodology richly draws from fieldwork-based community local knowledge to build the historical context, provide background, and develop a backdrop of social relations that produce the spatial patterns often represented in conventional GIS. These participatory GIS approaches, more than often are a complementary rather a contradiction of traditional GIS. Consequently, a better understanding of a spatially and socially differentiated peri-urban landscape is achieved. The PGIS methodology is found to be relevant in an African peri-urban context because it is culturally sensitive, relatively inexpensive and locally sustainable.

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