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(RE) DEFINING PERI-URBAN RESIDENTIAL SPACE USING PARTICIPATORY GIS IN KENYA

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ABSTRACT

Using Geographic Information Systems (GIS) for African urban planning and research is now becoming a reality. But there is limited technical expertise and the necessary infrastructure to support local government efforts in data-poor environments. As a result, the creation of urban geo-spatial databases have tended to reside in the central government, large municipalities, research institutions, donor funded projects and individual research initiatives. To date, such applications have focused on observable and quantifiable aspects of the urban built environment while experiential information has remained peripheral. This paper employs a participatory GIS approach to integrate community local knowledge with traditional urban spatial data. Our objective is to populate urban-based geo-spatial databases for a more robust understanding of quality of life in *Athi* River town, Kenya. The *Athi* River GIS includes formal data and local knowledge on land cover, land use, hydrology, topography, infrastructure, industry, service provision, and housing. Community data was obtained through mental mapping, focus group discussions, GPS-based transect walks, social histories of exclusion, oral narratives of land use, and relevant archival material. The study concludes that GIS in Kenya is being introduced within an empiricist and positivist epistemological and methodological framework. With more focus on the visual and quantifiable aspects of the built environment, the perceptions of disenfranchised peri-urban communities are being excluded. In the paper, a place-based (re) definition of residential quality of life is achieved by integrating community local knowledge into a GIS as an information layer. In the study, local knowledge and expert GIS data are thus found to be complementary.

Keywords: Participatory GIS, Peri-urbanization, Kenya

INTRODUCTION

Using geographic information systems (GIS), hereafter geospatial information technologies (GITs), for African urban planning and research 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 GIT applications in urban areas 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 Kenya for instance, the creation of urban geo-spatial 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 aspect of the urban built environment while the experiential component by the local communities has remained peripheral to these digital spatial databases. As a result, the understanding and definition of quality of residential areas for instance, has tended to be a function of proximity to social services, physical and social infrastructure, and housing among other things. These distance-driven and top-down models are mainly based on traditional urbanism thought and could be problematic and impractical in the socially and spatially differentiated peri-urban landscapes of African cities.

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 and (re)definition of (peri) urban residential space in Kenya. Specifically, the paper seeks to shed light on three main research questions. First, what are the potential limitations within traditional conceptualizations of African peri-urbanization and the 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). 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.

The second question seeks to understand how participatory GIS approaches might contribute in (re)defining peri-urban residential spaces in data poor urban environments in Africa. 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 (Harris and Weiner, 1998). 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 uneven residential development 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

The African population that resides in areas categorized as peri-urban has increased steadily in the past two decades. A decade ago, for instance, Browder and Bohland (1995) observed that approximately 42% of the developing world's total urban population lived in informal settlements. More recently, a study by the United Nations Centre for Human Settlements (UNCHS) noted that 30% of these informal settlements are located in the urban fringe (Baker 2002). The presence of peri-urban settlements has therefore not gone unnoticed. 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).

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 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. One such practice has been the use of GIS in urban space planning.

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 on 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 geo-spatial 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 conventional 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 Public Participation GIS (PPGIS) approaches is well captured by Weiner et al. (2002)[1]. 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

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

the integration of local community perceptions into conventional GIS databases. Despite variations in terms of reference, these approaches have been collectively referred to as participatory geographic information systems (Weiner et al. 2002). The methodology employed in this study thus links modern geo-spatial information technologies including GIS and remote sensing with traditional public participatory methods. Specifically, perceptions and experiences of local communities are integrated into a conventional GIS database as layers of information to build an in-depth understanding of uneven development of residential space in *Athi* River town.

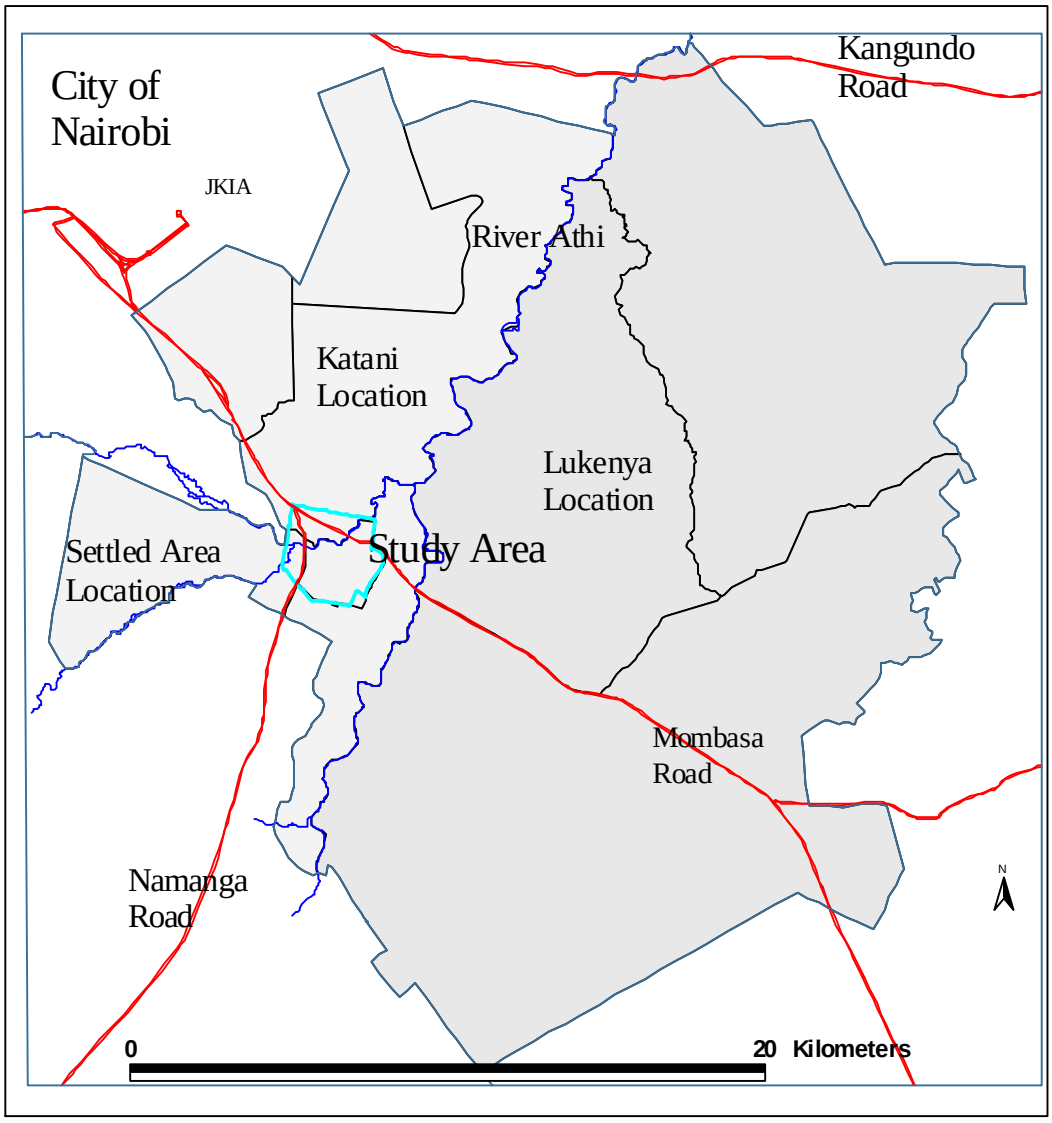

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Figure 1: Administrative locations of Athi River Division in Machakos District.

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).

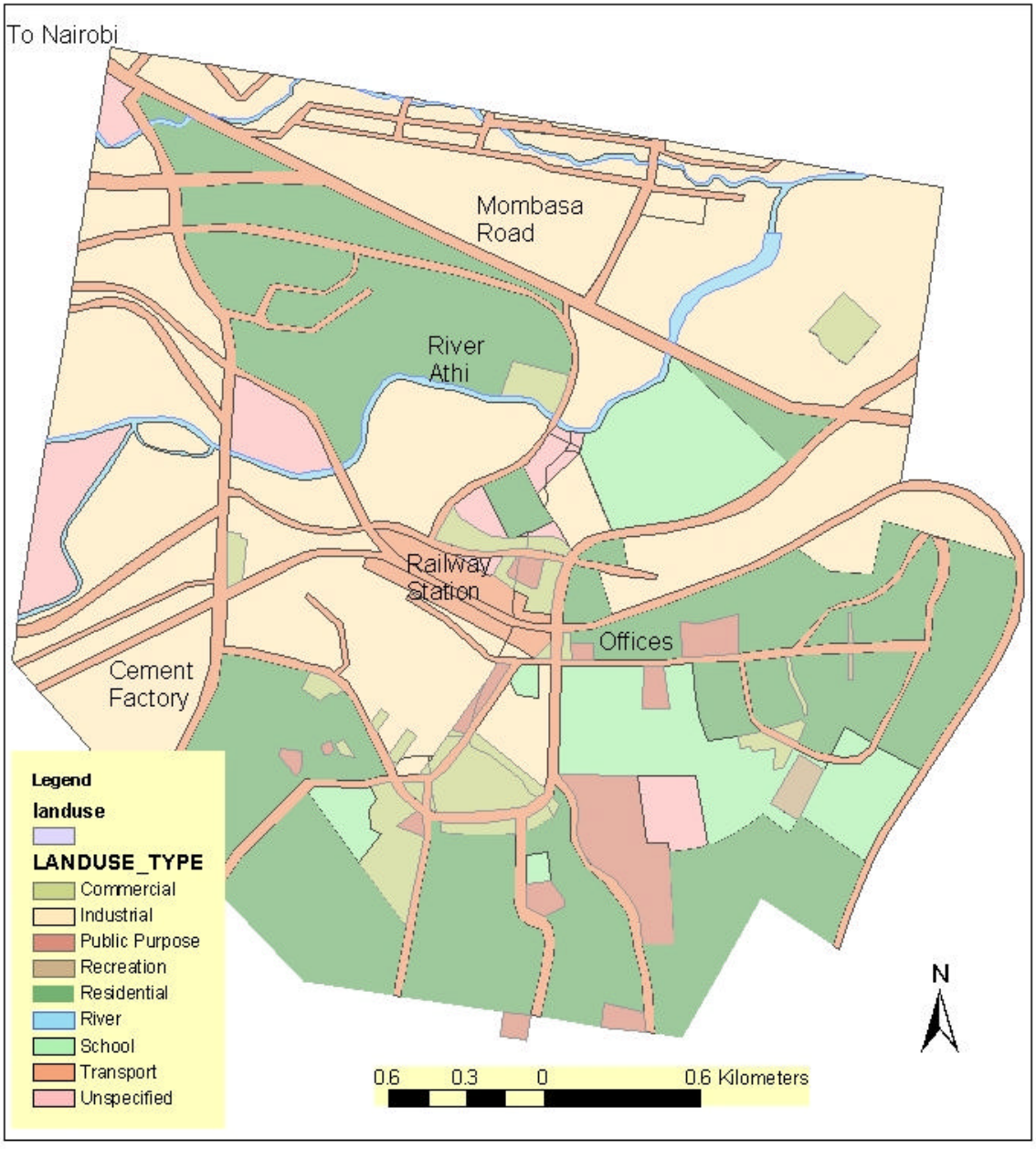

Figure 2: A 2002 Athi River town land use map

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.

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.

SUMMARY OF FINDINGS AND CONCLUSION

Earlier in this paper, the authors identified some misunderstandings 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. 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 inputted 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 conventional 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 drive land access and use. In this way, a CiGIS contributes to understanding the intricate causal spatial and social interrelationships between land use, political and economic processes prevalent in peri-urban towns in Kenya that would have been otherwise unattainable in a conventional GIS environment.

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 conventional 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 conventional GIS may spatially visualize and represent 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 conventional GIS setting (in that particular setting).

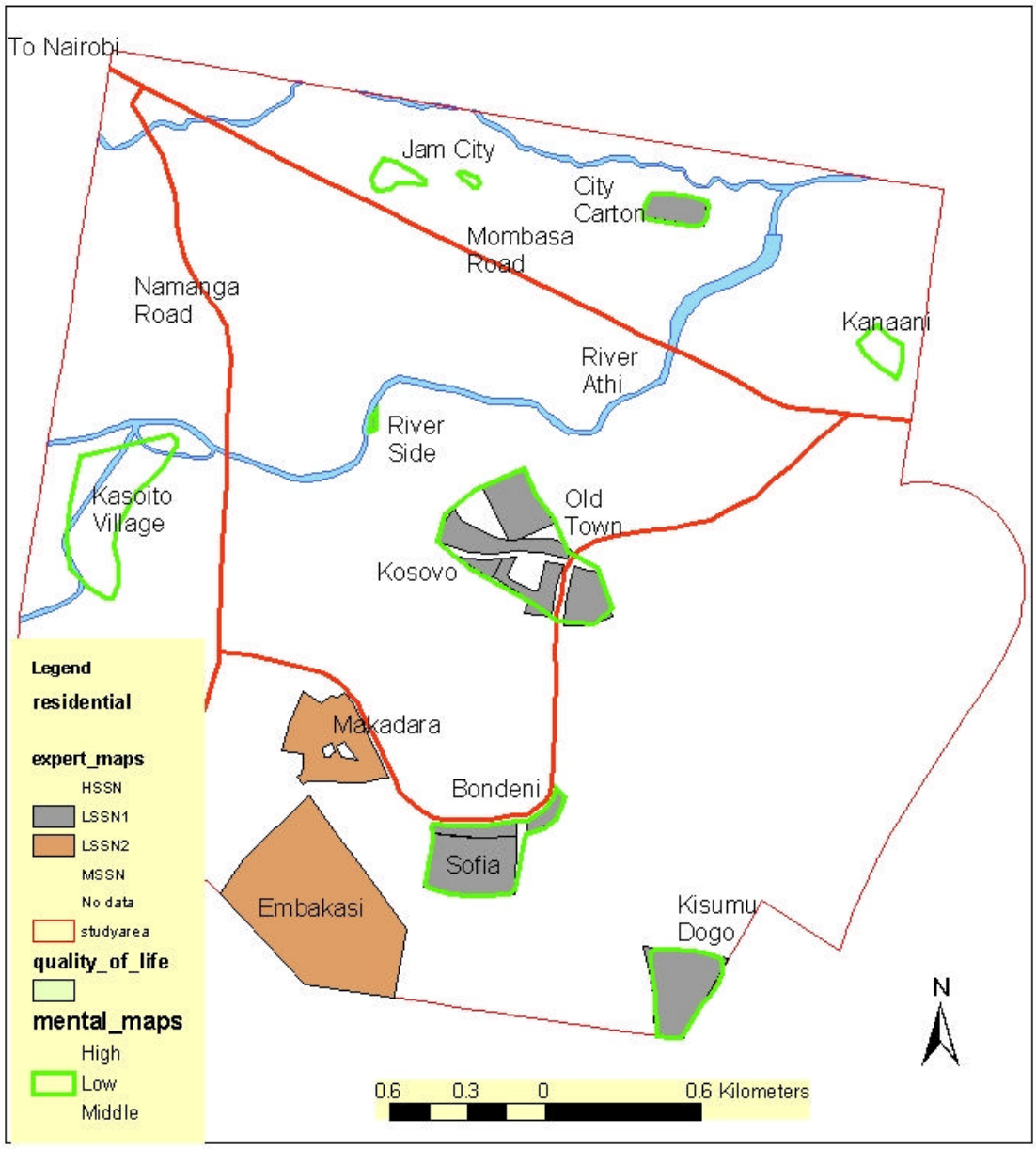

Figure 3: Local community mental maps of relatively low quality of life neighborhoods in Athi River town contrasted with expert knowledge of low social status neighborhoods

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 conventional GIS through the integration of community local knowledge as an information

layer to represent interests of often-marginalized groups. The methodology richly draws from local community knowledge acquired through fieldwork 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 complementary rather than a contradiction of conventional GIS. Consequently, a redefinition of peri-urban residential space in a cultural and political context typified by gaps in spatial data as well and differential access to information and resources is achieved.

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