IMPACT OF LOCATIONAL FACTORS ON VARIATION IN INTER AND INTRA URBAN SLUM PATTERN AND DEPRIVATION

THE CASE OF KISUMU-KENYA

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Intelligence plus character-that is the true goal of education

Dr. Martin Luther King Jr. (1929-1968)

Dedicated to my loving family

Daddy, Mummy, Joy, Casper, Junior, Toto, Petit and Safari…

whose devoted love, support and belief in me has always brought me to the successful accomplishments of all my aspirations.

Your loving Idiot Dodo.

ABSTRACT

The increasing rate of urbanization continues to pose a great challenge in the less developed countries. As their urban population grows, the number of slums often notably increases. While this research acknowledges the dynamics that influenced the growth and pattern of slums in Kisumu Town Kenya; most importantly it draws attention to the impact of key locational factors and the role of policy on inter and intra variation in slum pattern and deprivation. An extended slum belt exists along the eastern part of the municipality within which eight distinct sub-locations are found. The study focuses on two of these sub-locations-Manyatta "A" and Nyalenda "A".

Three key locational factors were examined namely tenure, proximity to a major water source and availability of road infrastructure. In exploring the influence of these factors on slum pattern and deprivation, several methods were applied. Satellite image analysis gave insight into the slum pattern through the combined evaluation of computed spatial metrics and extracted housing typologies: family housing, rental housing and mixed use housing. The Contagion index of 16% and 41% indicate more disaggregation of patches for Manyatta 'A' than Nyalenda 'A' respectively. The Patch density and Edge density values function as expressions of spatial heterogeneity and indicate dispersed patch distribution in Manyatta 'A' contrary to Nyalenda 'A' which is clumped. This supported the classification of slum growth into three categories: expansion, densification and intensification.

The variation in slum structure is likewise evident in the deprivation levels. A composite "slum index" was also derived from household survey data, providing a unique approach for assessing deprivation from the perspective of an areas level of "slumness". The slum index for Manyatta 'A' and Nyalenda 'A' show a slight variation at 2.35 and 2.25 respectively; however greater intra variation is evident with the slum index ranging from 1.69-2.79. Analysis into the association between tenure as a locational factor and the individual indicators that constitute the slum index confirmed a relationship with the indicators. Overall indication was that renters are worse off in terms of lack of access to water, poor housing quality and overcrowding, but not in the case of access to sanitation and electricity where no association was identified.

The results indicate that indeed variation in development patterns and levels of deprivation are evident and are associated to the identified locational factors. These effects are further accentuated by policy implication or lack thereof. This is evident in the failure in enforcement of the existing zoning guidelines resulting in 74% and 93% of unauthorized housing units in Manyatta 'A' and Nyalenda 'A' respectively.

Key words: Locational factors, inter and intra variation, slum pattern, spatial metrics, slum index, "slumness", deprivation.

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Liliane Mupende Uwanziga,
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1. INTRODUCTION

This introductory chapter provides a background and justification to the research and describes the research problem. It elaborates the aim, objectives and questions designed to respond to the research problem. The overall approach to the study is also presented in the conceptual framework, research design and research matrix. In conclusion it highlights the structure for the remaining chapters of the thesis.

1.1. Background and justfication

The increasing rate of urbanisation continues to pose a great challenge in the less developed countries. As their urban population grows, the number of slums often notably increases. Estimates show that should the current trend persist, the slum population will reach 1.4 billion by 2020; with this population facing dire conditions far worse than those of the rural populace (UNHabitat, 2006).

Many slum upgrading programmes introduced as solutions to the evidenced deprivation have, however, resulted in a conundrum of effects. Some of these have been manifested in negative impacts such as gentrification in cases where infrastructure upgrade has been applied; transfer into other forms of deprivation like loss of livelihood and disintegration of social networks, where relocation to better housing and serviced sites has been the approach. In this aspect, it is crucial to truly comprehend the locational factors that define a slum in order to grasp the dynamics that underlie its development.

The growing interest from a varying range of organizations (Government, NGO's, International Agencies), has placed importance on mapping and recognizing the role of slums in the urban growth process. In this study, focus is placed on exploring patterns of the slum and relating them to identified locational factors that play an influencing role. Agnihotri (1994) best describes locational factors in the context of slums as aspects tied to a specific locality that are instrumental to the definition of the slums pattern. Elaboration of this definition is seen in the distinction between inner-city slums and peripheral settlements (idem). This further forms the base for the assessment of the nature of deprivation that is realised in these slums and ultimately review of policy implication.

1.2. Research Problem

The research of Weeks et al. (2007) has shown that it is possible to measure the level of "slumness" of a neighbourhood using census data and geospatial aggregation techniques in combination with assessment of land cover metrics. It can be inferred that the census data and household survey data provides the state of a slum in the perspective of socio-economic status of the residents, whereas land cover metrics contribute to the physical set up of the neighbourhood. Land cover metrics make possible the quantification of the structure and pattern of landscapes (Herold, 2001; Sliuzas & Kuffer, 2008). This socio-economic and physical data have been linked to the locational make up of a specific slum and can be exploited to quantify the level of deprivation. These measures of deprivation, better educate the policy maker on what best intervention measures to apply to the local context.

The study area of Kisumu town in Kenya continues to face rapid growth which has resulted in increased urbanisation of poverty, expansion of informal settlements and informal trading (UNHabitat, 2005b). Amid this development are evident poverty levels with 48% of the Kisumu population living below the poverty line (idem). These have been exceptionally evident in the peri-urban areas of the town as a result

of the influence of the rural-urban transition brought on by the larger boundary of Kisumu District. With the introduction of the City Development Strategy (CDS), the town aims at addressing the challenges that arise from this continued urbanisation.

Although previous research into slum pattern and deprivation has focused on understanding the dynamics involved, minimal focus has been placed on the importance of the link between locational factors and policy intervention. It is against this background that the research aimed at exploring the slum pattern in Kisumu town and identifying the key locational factors that have influenced it. Their impact on the spatial variability in the deprivation levels is assessed and the role of policy intervention reviewed.

1.3. Research Aim, Objectives and Questions

1.3.1. Aim

The main aim of this study is to analyse the impact of locational factors on variation in spatial pattern and deprivation of slums in Kisumu town.

1.3.2. Objectives

1. Identify the pattern of the slum belt in Kisumu town;
2. To determine the effect of locational factors (socio-economic and physical factors) on slum pattern and deprivation in Kisumu slums; and
3. To assess the impact of policy intervention on variation in the pattern and deprivation in the slums.

1.3.3. Research Questions

1.1 How can we use image analysis in measuring slum patterns?
1.2 What land use model does the slum pattern emulate?
1.3 How homogeneous is the pattern in the selected slum sub-locations?

2.1 What locational factors have influenced the emergence of the slum belt in Kisumu town?
2.2 How can we build the slum index and use it to measure the spatial variation of deprivation?
2.3 To what extent are the different locational factors manifested into deprivation?

3.1 What policy interventions have been implemented in the slums of Kisumu?
3.2 What is the impact of these interventions on the slum pattern and deprivation in the slums?

1.3.4. Conceptual Framework

Figure 1-1 highlights the main concepts that underlie this research. The study elaborates the pattern of Kisumu slums and reviews the role of the original land use model and physical plans of Kisumu. This pattern was evaluated two fold; through the assessment of socio-economic factors using the slum index (Weeks, et al., 2007) and physical factors using the extraction of land cover metrics (percentages of cover type, spatial metrics). A comparative analysis of the individual locational factors to the level of deprivation inferred from the slum index enabled assessment of spatial heterogeneity/homogeneity of the slums.

The premise of this conceptual framework is that there is evidence of a unique pattern in the slums of Kisumu town and that it can be quantified and qualified by understanding the influence of the locational factors. In identifying the role of policy, special attention was placed on distinguishing the different forms of intervention and their impact on the level of deprivation.

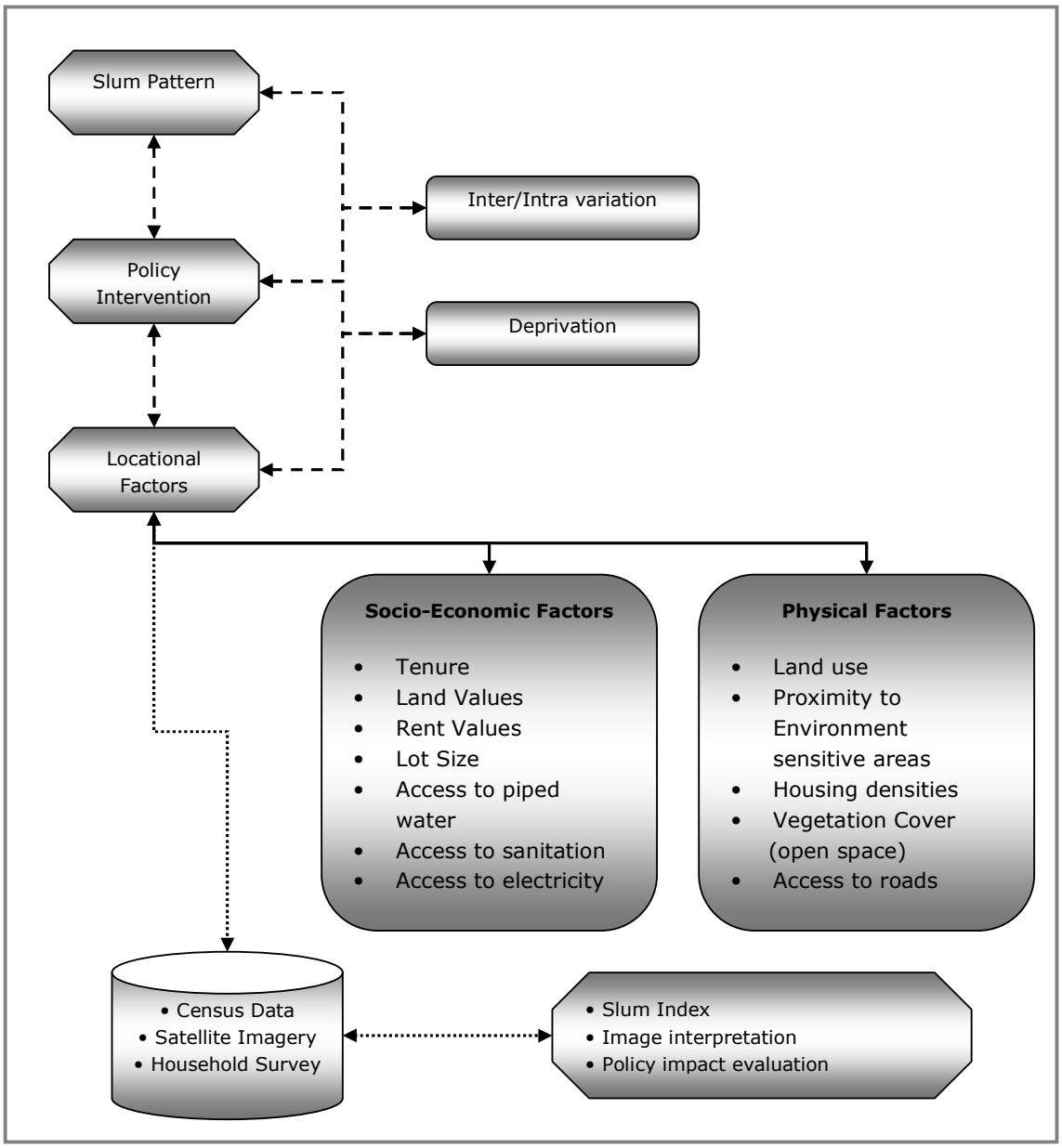


Figure 1-1: Conceptual Framework

1.3.5. Research Design

Figure 1-2 below summarises the key sequences that were undertaken during this research. These are summarised into 3 iterative phases: Pre-field work phase, Field work phase and Post-field work phase. The iterative process pointed towards all procedures feeding back into each other to ensure the satisfactory addressing of the research problem.

Development of the research problem was initiated through literature review and formed the basis for the elaboration of the research objectives and questions required to respond to the problem. Furthermore literature review served to identify key concepts that support the research, with emphasis being placed on methods and approaches for operationalizing the conceptual framework in Figure 1-1. In addition, key terminologies linked to the research problem were introduced.

Data analysis included exploration of the existing secondary data: Visual interpretation and supervised classification of the GeoEye imagery (2009) for extraction of the spatial patterns and housing typologies. This formed the basis for the evaluation of land cover metrics to assess the homogeneity of the selected slum sub-locations (Sliuzas & Kuffer, 2008).

Adapting from the framework of Weeks et al (2007), socio-economic data has been used to develop a slum index based on the socio-economic factors described in Figure 3-4. However in lieu of applying this index to enumeration areas, this study used the lowest level of local administrative boundary-the cell level (nyumba kumi/villages). This was related to the slum pattern and ultimately assisted the researcher to evaluate the impact of the locational factors on deprivation. This was supplemented by household survey data drawn from a sample of the population of the selected sub-locations. The household survey is used as a tool to validate the premise defined in the conceptual framework. Questionnaires were administered to a representative sample of the strata formed from the administrative village units of the selected slum sub-locations. Furthermore field observation acted as ground validation for the visual interpretation and classification and supported the identification of housing typologies. Data analysis yielded various research findings which were used to draw conclusions and recommendations.

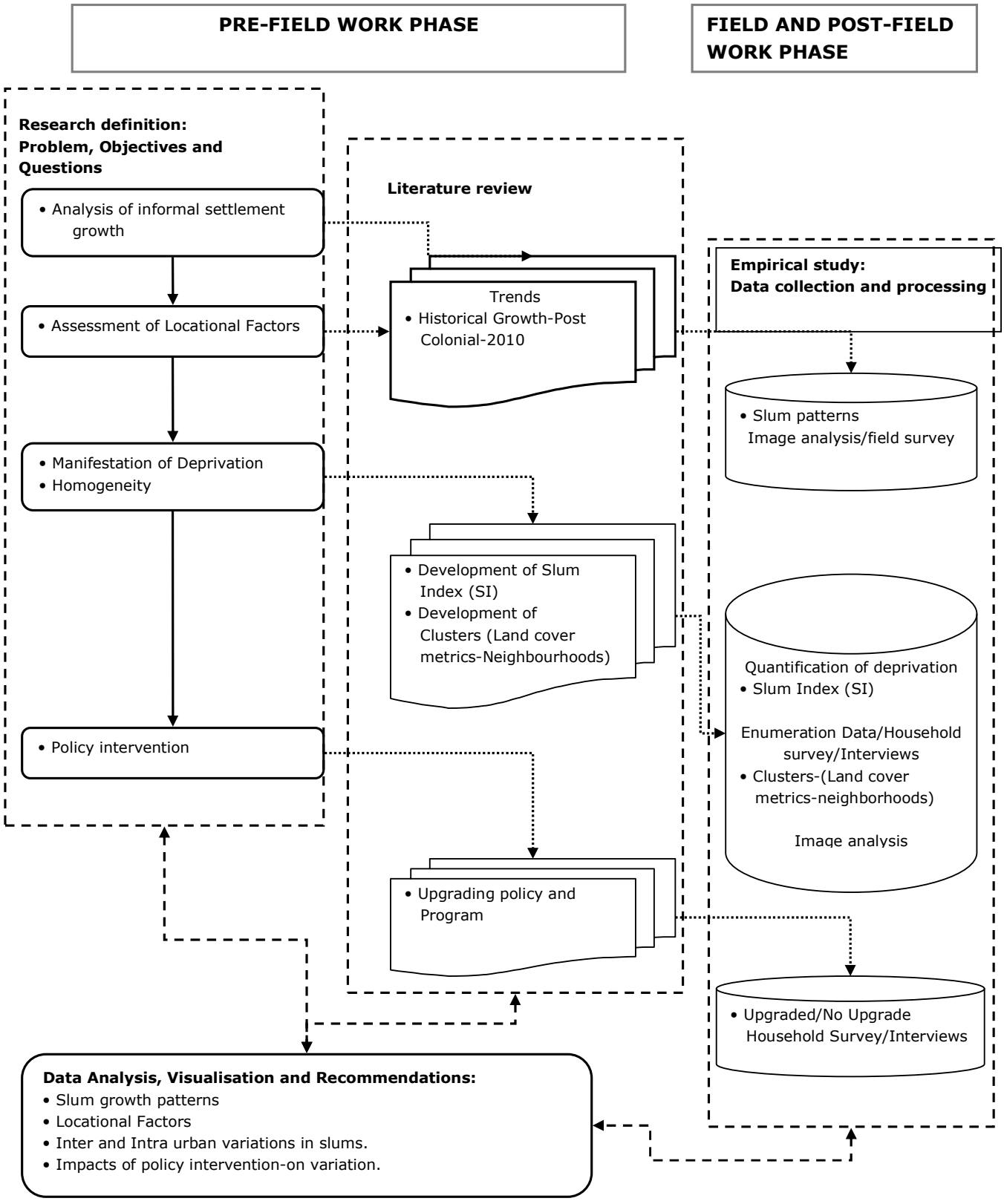


Figure 1-2: Research Process

1.3.6. Research Matrix

In Figure 1-2, the research matrix summarises the data used, sources of the data, collection tools and duration of acquisition. These are related to the methods of analysis required to adequately answer the questions to the sub-objectives that contributed to achieving the main aim of the research.

No.	Specific Research Objectives	Research Questions	Data Required	Data Sources	Data Acquisition	Time	Methods of Analysis
1.	Identify the pattern of the slum belt in Kisumu town.	How can we use image analysis in measuring slum patterns?	Related literature, Land use map, Geo eye 2009 Imagery, Interview data	Secondary/ Primary	Literature search, Interview/ Focus groups	Pre-field/ Field work	Literature review, Visual interpretation and Supervised image classification
		What land use model does the slum pattern emulate?	Related literature, Land use map, Geo eye 2009 Imagery, Interview data	Secondary/ Primary	Literature search, Interview/ Focus groups	Pre-field/ Field work	Literature review, Visual interpretation and Supervised image classification
		How homogeneous is the pattern in the selected slum sub-locations?	Related literature, Land use map, Geo eye 2009 Imagery, Interview data	Secondary/ Primary	Literature search, Interview/ Focus groups	Pre-field/ Field work	Literature review, Visual interpretation and Supervised image classification
2.	To determine the effect of locational factors (socio-economic and physical factors) on slum pattern and deprivation in Kisumu slums.	What locational factors have influenced the emergence of the slum belt in Kisumu town?	Related literature, Socio-economic data,	Secondary/ Primary	Literature search, Interview/ Focus groups, H/H survey	Pre-field/ Field work	Literature review, Statistical analysis (Slum Index dev.), GIS Analysis & visualisation
		How can we use image analysis in measuring slum patterns?	Related literature, Socio-economic data,	Secondary/ Primary	Literature search, Interview/ Focus groups,	Pre-field/ Field work	Literature review, Statistical analysis (Slum Index dev.), GIS analysis &

					H/H survey		visualisation
		To what extent are the different locational factors manifested into deprivation?	Related literature, Socio-economic data,	Secondary/ Primary	Literature search, Interview/ Focus groups, H/H survey	Pre-field/ Field work	Literature review, Statistical analysis (Slum Index dev.), GIS analysis & visualisation
3.	To assess the impact of policy intervention on variation in the pattern and deprivation in the slums.	What policy interventions have been implemented in the slums of Kisumu?	Related Literature	Secondary	Literature Search	Pre-field work	Literature review
		What is the impact of these interventions on the slum pattern and deprivation in the slums?	Related Literature Socio-economic data	Secondary/ Primary	Literature search H/H survey	Pre-field/ Field work	Comparison of Slum Index to Land cover metrics

Table 1-1: Research matrix

1.3.7. Expected outcomes of the research

The research provides insight into the following key aspects:

- Nature of slum pattern and deprivation in Kisumu town;
- Locational factors and their link to slum pattern and deprivation;
- Evidence or lack thereof of inter and intra variation in slum pattern and deprivation;
- Policy implications on slum growth, pattern and deprivation.

1.4. Significance of the research

This research will be beneficial to a varying range of individuals and organisations:

- To the Government and Non-government organisations addressing the challenges of slum growth and deprivation, it will demonstrate the importance of locational factors in targeting poverty neighbourhoods;
- Furthermore, with possible future expansion into the research it provides the same organisations with a possible framework for monitoring and evaluation of policy programs by incorporating time series;
- Lastly it provides an opportunity for future research.

1.5. Structure of thesis

This thesis comprises of eight chapters as summarised below:

Chapter 1: Introduction

This chapter outlines the background and justification for the research. This is achieved through elaboration of the research problem, identification of the research objectives and questions; and introduction of the conceptual framework and research design that enabled the researcher to achieve the identified research objectives.

Chapter 2: Dynamics of Urban Slum Growth

Chapter two forms the theoretical backbone of the research and introduces literature on key concepts underlying the study as a whole-urban sprawl, slum pattern, deprivation and locational factors.

Chapter 3: Study Area

While providing a general description of the study area; this chapter also serves to link the study area to some of the concepts described in chapter two. It illustrates a range of characteristics of the area such as its historical growth, physical and administrative features, demographics and socio economic conditions among others.

Chapter 4: Methodology and data collection

Structured into three phases; pre-fieldwork, fieldwork and post-fieldwork, this chapter establishes the techniques applied for data collection, processing and analysis in order to respond to the research objectives and questions.

Chapter 5 and 6: Findings of the research

Chapters 5 and 6 present the main findings of the research. Chapter 5 looks into the pattern of Kisumu slum with reference to the structural plan, zoning guidelines and emerging housing typologies. Furthermore it introduces the key locational factors that contribute to this pattern-Tenure, Proximity to major roads and a major water source. Chapter 6 leads into the measurement of deprivation relative to the slum pattern and locational factors identified in the previous chapter. Furthermore review of the impact of policy intervention on slum pattern and deprivation is carried out.

Chapter 7: Conclusion and Recommendations

The last chapter provides a summary of the key findings and proposed recommendations for application of this research and the prospect of future research initiatives.

2. DYNAMICS OF URBAN SLUM PATTERN AND DEPRIVATION

This section forms the theoretical background to the study and lays emphasis on the defining concepts that influence slum growth, pattern and deprivation. It also introduces literature on various approaches that have been previously applied and have been adapted to the implementation of this study.

2.1. Definition of Slums and Deprivation

Slums have continued to be a phenomenon that is complex to define; but over the years focus has been placed on the element of a disadvantaged component of the urban society that is deprived of basic necessities. In this context, deprivation is viewed as a state of individual disadvantage relative to a wider society; Townsend (1987) attributes deprivation to specific conditions (physical, environmental, social states or circumstances) rather than the lack of resources. In understanding the different forms of deprivation, a relation is drawn to the analysis of the locational factors that define the status of a specific individual relative to the society they are a part of.

Differences in access across geographic zones and social groupings have led to the characteristics and dynamics that define slums and contribute to their deprivation (Daniere & Takahashi, 1999). This is further elaborated in the research into intra-urban geography of deprivation where weight is given to the impact of spatial dependency and heterogeneity when measuring poverty (Longley & Tobón, 2004). It is, therefore, evident from previous research that, the concept of variation in the manifestation of deprivation is a crucial angle in the study of slums. Also noted is the spatial clustering effect on deprived areas prone to environmental injustice hence the need to analyze and appreciate the role of environmental issues in the evolving patterns of poverty and deprivation in slums (Msilu, 2009).

2.2. Urban sprawl and slum pattern: Measurement and analysis

Urban sprawl is commonly evident along the urban fringe with an inclination towards slum development where the planning system has failed to match this sprawl. Research into slum development as a growing phenomenon has led to the emergence and evolution of technologies such as Remote Sensing, Geographical Information Systems (GIS) and Global Positioning systems (GPS) (Sudhira, et al., 2003). These have contributed to the analysis of spatial and temporal data in the effort to quantify the dynamics and trends of growth on spatial scale. The extraction of urban data from remote sensing images, however, can benefit from the local knowledge of the development processes (Sliuzas, et al., 2010).

2.2.1. Urban morphology: Form, function and layout of the urban slum

Urban morphology looks into the physical form of urban settlements and is a function of the changes in population growth, transportation and socio-economic functions (Brunn, et al., 2003). Three major land use models have contributed to understanding the complexity of the urban physical form; Burgess concentric zone model, Hoyts sector model and the multi nuclei model of Ulmann and Harris (Pacione, 2005). Despite their different approaches to land use allocation, they share a common view on the general zones defining their land use theories-CBD (Central Business District), inner city, industry and residential zones[1]. Over time the innovative elaboration of these classical models has given rise to the introduction of

[1] Also referred to as CBD (Central Business District), inner city, suburbs and rural-urban fringe.

concepts such as Ebenezer Howard's garden city concept, Conzen's fringe-belt and burgage cycle; which will explicitly contribute to the exploration of the pattern of urban growth and town landscape[2] of the case study area (Pacione, 2005; UNHabitat, 2005b; Whitehand, 2001; Whitehand, et al., 1999).

Usman, et al (2009) acknowledges that most cities in the third world countries have grown from villages as a mechanism to address the increasing urban needs. His review of the changes in the urban morphology, the driving forces and their impact on policy provides a good framework for the understanding of slums that have evolved from previously rural land.

2.2.2. Remote sensing: Visual and digital analysis

Remotely sensed data support the analysis of slum growth and pattern. Visual image interpretation and supervised classification have been applied in delineation of spatially heterogeneous slum areas (Sliuzas & Kuffer, 2008). Unique morphological and location aspects are seen to yield typologies that define poverty areas as extracted from remotely sensed images. The researchers further appropriate these delineated areas to clusters defined by a socio-economical index of poverty; in this case the index of multiple deprivation-IMD (idem). Inclination has been shown towards a relative correlation between neighbourhoods identified from classified images and socio-economic indices; with variability being enhanced by the differing land cover and socio-economic characteristics respectively (Sliuzas & Kuffer, 2008; Weeks, et al., 2007).

Further research into urban analysis has been supported by the combination of remote sensing and a varying range of spatial metrics. Herold (2001) recognises that the urban environment constitutes three main classes-built up, vegetation cover and water bodies. In the analysis of urban pattern and land use change these classes can be truly quantified using spatial metrics which he describes as "quantitative indices that can be used to describe structures and patterns of a landscape (idem). Previous research has tackled the importance of application of spatial metrics in the analysis of land use/land cover change, urban growth, sprawl and pattern (Bhatta, et al., 2010; Herold, 2001; McGarigal & Marks, 1995); with a classification of these metrics into three distinct levels-patch, class and landscape. However, Tsai (2005) is seen to further classify the main spatial metrics used in urban sprawl measurement into three interrelated classes-density, diversity and spatial-structure pattern. A combination of the various views on the categorization and use of spatial metrics will be applied to select the best metrics for the quantification and analysis of the study area.

2.3. Importance of Locational Factors

The importance of geographic location has over time evolved as a key aspect in the assessment of development issues, with recognition of the informative nature of locational factors in exploiting inter-regional differences (Martínez, et al., 2008). The clustering of cities is into groups of shared shelter characteristics; durability of structures, sufficient living area, access to safe water, access to improved sanitation, connection to water and connection to sewerage. Their hypothesis holds that similarities are evident in cities within a given region; however this clustering approach is limited in its depiction of intra-regional differences (idem). The approach of delineating neighbourhoods from census enumeration areas based on image derived measures of land cover has, however, in this aspect proved a successful approach in the analysis of intra-city variations (Stow, et al., 2010).

Recognition has been given to the increasing disparities between the rich and poor in both the social and spatial context (UNHabitat, 2008). Elements such as access to employment opportunities and income level are considered a driving force for urban growth and are often used in the differentiation between the

[2] According to Conzen's tripartite division of the town landscape comprises of ground plan (streets, plots and block plans of buildings), building fabric and lastly land and building utilization (Whitehand, 2001).

rich and the poor. This can be correlated to the purchasing power of individuals hence their ability to access basic amenities which in this study will be addressed in the framework of locational factors. An example of these locational factors could be the cost and availability of land, proximity to economic centres; these can be explored to define the attraction fundamentals that underlie slum growth.

The locational factors highlighted above are not restricted to individuals but can be exploited through the local solidarity networks. Opportunities provided in the framework of concentration and segregation draw attention to the importance of the context of local communities and neighbourhoods (Bolt, et al., 1998). Having acknowledged the importance of locational factors, connections that are created in the process slum growth can be explored. This can be reviewed in the context of the impact of various socio-economic intervention programmes that are resultant of these networks. These are programs such as micro-banking systems, intermediary slum upgrading programs that involve the residents in the improvement of their livelihoods.

2.3.1. Selection of pertinent locational factors-Tenure

It is widely acknowledged that insecurity of tenure plays an important role in the definition and identification of slums. UNHabitat (2003) highlights that tenure status in slums is quite diverse and may be associated with legality in two aspects-land ownership and construction. In differentiating between the slum dynamics in the rural and urban setting, a propensity towards higher levels of security of tenure in inner-city slums is evident (idem). Tenure regularization is taking on the forefront in enabling the urban poor to improve their living conditions (Durand-Lasserve & Royston, 2002). Land rights as an asset guarantee credit worthiness and increase the probability of improvement of squatter settlements. However, in the slum formation process, UNHabitat (2003) categorises slums into two distinct categories- "declining areas" and "progressing settlements". Relevant to this research is the "progressing settlements" with specific reference to illegal settlements and subdivisions in which case initial ownership of the land is predominant. In the transition from rural to urban, farmers perceive the increased value in housing as an alternative revenue source over farming products and resort to subdivision of their land and development of rental units. Agnihotri's (1994) slum classification in Figure 2-1 elaborates slum types along legal status, tenure of occupancy and types of habitation. This is the foundation for the researcher's selection of tenure as a locational factor as it suffices to show variation along different dimensions.

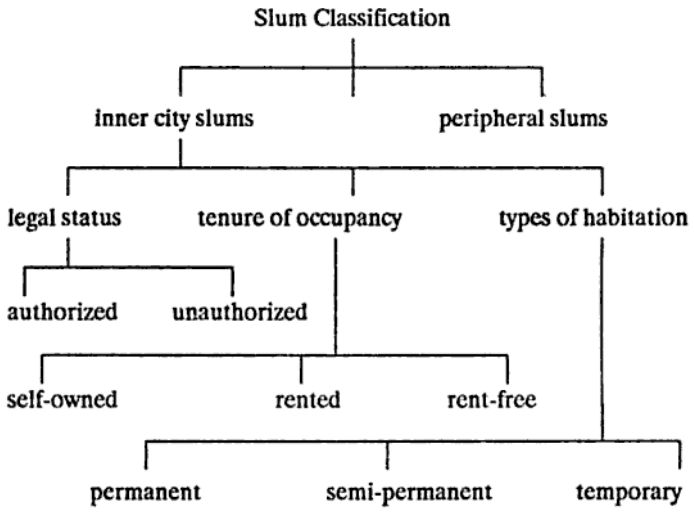


Figure 2-1: City-centre-periphery slum classification

Source: (Agnihotri, 1994)

2.3.2. Selection of pertinent locational factors-Proximity

Proximity introduces the element of locational advantage with reference to specific factors. Liveability of a slum is associated with the type of locational factor influencing the character of that slum; Agnihotri (1994) combines various factors into three broad categories-natural, cultural and combined natural-cultural factors. We draw from these categories the importance of proximity to roads and a major water source as they play a leading function in the spatial growth pattern and resulting deprivation levels in Kisumu town.

2.4. Variation in inter and intra urban slum pattern

Boundary delineations in the traditional set up of urban-rural transition are seen to suffer from social, political and economical factors. In the perspective of this study, the slum pattern will be assessed from the point of arbitrary physical delineations formed to define the respective slum clusters; also referred to as slum sub-locations. Inter and intra variation will in this case apply to the disparity between and within these slum clusters respectively. The perceived heterogeneity from the geography of the slum sub-locations will be explored to show the impact on slum pattern and resulting deprivations. Weeks et al (2007) describe a slum as a continuum of "slumness"; this aids in the assessment of neighbourhoods for their level of continuity and similarity versus disparity in character in the case of homogeneity and heterogeneity respectively.

Appreciation of the interaction between the factors above (social, political and economic) can contribute to the reduction of socio-spatial and economic inequalities through equitable distribution of resources (Giraut & Maharaj, 2002). This better improves the opportunity for better targeting of policy interventions that appropriately respond to the challenges faced by the respective slum sub-locations. This constitutes the need to identify sound methods to identify and spatially define slum areas in various contexts with acknowledgement of the possible variation in the character of these slum areas (Sliuzas & Kuffer, 2008).

Variability in slums can be attributed to a number of slum characteristics such as the socio-economic status of slum dwellers and the variation in land cover of the slums (Weeks, et al., 2007). The approach of identifying neighbourhoods quantitatively through the use of a slum index exploits the use of census and household survey data (idem). An alternative method is applied in the image derived neighbourhoods created from enumeration areas sharing same vegetation measures (Stow, et al., 2010) . A combination of these approaches in the study of Kisumu slums will serve to analyse variation in the sub-locations through exploring both socio-economic variables and physical variables. The scope of the study will focus analysis at the scale of neighbourhood boundaries rather than city boundaries.

2.5. Analysis of association between locational factors and individual indicators

In assessing relationships between categorical data Field (2009) recommends the use of Pearson's chi-square test. Its statistics measure the probability that the expected count in a specific occurrence is likely to be realised in the actual count. It works along the theory of proving or nullifying a hypothesis. The chi-square test does not result in identification of causality (Field, 2009; Zibran, 2007), but the interaction between explanatory and response variables facilitates in specification of the directionality and significance of the relationship. The locational factors and individual indicators are classified into binary data for analysis in later chapters.

2.6. The role of policy in slum growth, pattern and deprivation

The mitigation of slum growth and deprivation are now globally recognised challenges. Various initiatives have been introduced to curb this continued growth of the slum population; however most slum policies have taken on a more retroactive approach to dealing with slums-relocation or upgrading. The 7th Millennium Development Goal (MDG) aims at "improving the living conditions of 100 million slum dwellers by 2020". Payne (2005) emphasises the need to take on a radical approach in addressing this most challenging MDG through a "twin-track approach" which supports the improvement of exiting slums, but also encourages the introduction of regulatory frameworks to avoid new slums from emerging. Discussions on policy implication cannot be done without addressing the underlying regulatory frameworks and tools that drive the policy.

UNHabitat (2003) focuses on the importance of policy reforms and institutional changes. Review of policy tools such as targeted subsidies, basic land use planning and urban transport management are highlighted. Continued slum growth and deprivation is attributed to inadequate development control mechanisms, however, Ondiege and UNHabitat (1999) also cite inadequate manpower, finance, equipment and political interference as other factors affecting development control. The government's role is depicted as enforcement of land use plans, zoning guidelines and building codes along with the provision of physical and social infrastructure.

2.7. Summary

This chapter reviewed previous research and established the importance of spatial pattern, locational factors and deprivation to this study. Fundamental terminologies such as inter and intra variation, "slumness" and heterogeneity are emphasized. Furthermore review of previous research assisted in the identification and justification of the selected techniques applied in the implementation of this study: satellite image analysis, spatial metrics, slum index and chi-square test.

3. STUDY AREA

An introduction to the study area is crucial in providing context to the research problem. This chapter presents background information on the study area's physical and administrative features, demographics and socio economic conditions. In addition the historical growth is summarised and some concepts from chapter two are linked to the study area: locational factors and policy.

3.1. Background of the study area

As the third largest town in Kenya, Kisumu town forms the centre of the administrative Kisumu District boundary and Nyanza province respectively. It covers an area of about 417km² with an almost even distribution of area between dry land and water base which hosts a population of approximately 620,000 (2010 census). Its economic activities have been seen overtime to orient from its role as a railway terminus and port into an economic hub serving the Western region of Kenya and its neighbouring countries.

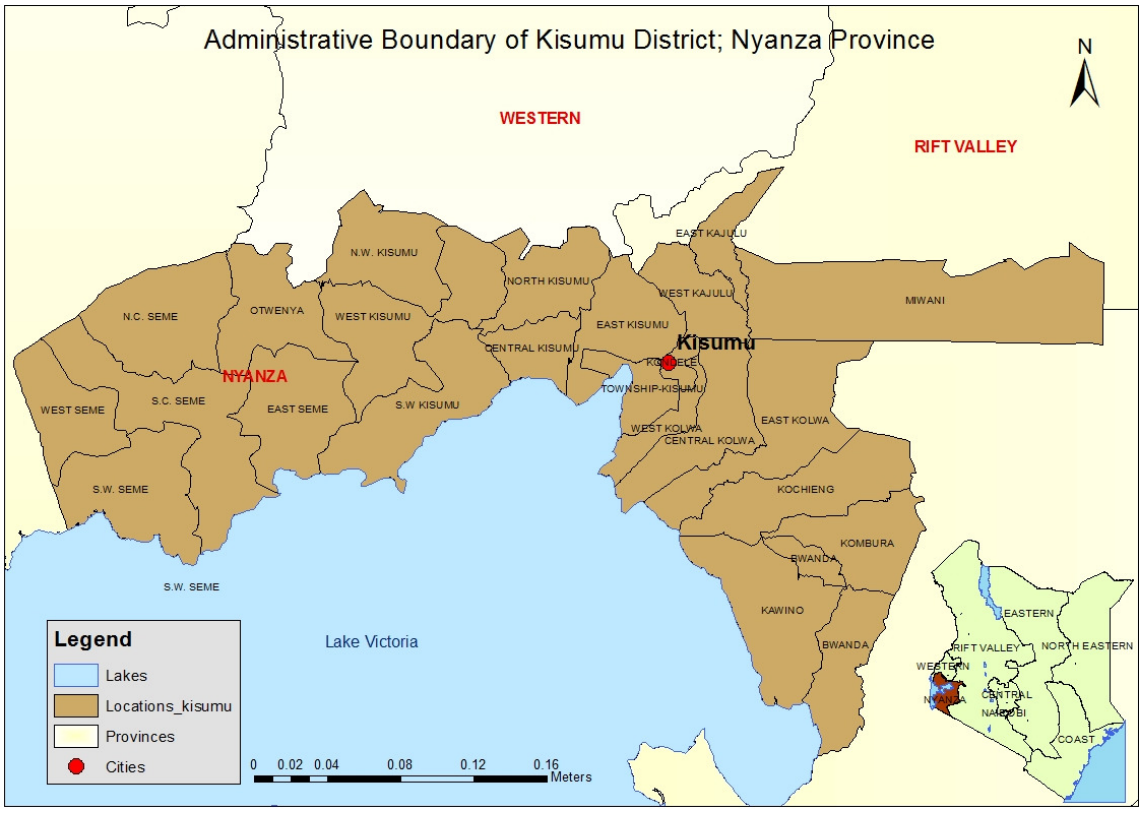


Figure 3-1: Map of Kisumu administrative boundary

Despite its economic growth Kisumu town has continued to face high poverty levels with 48% of the population living under the poverty line. Kisumu town is now working within two localised frameworks to address the issues that contribute to these poverty levels; the Poverty Reduction Strategy Paper (PRSP) and Economic Recovery Strategy for Wealth and Employment Creation respectively. The PRSP focuses on 7 sectors (Ministry of Finance and Planning, 1999):

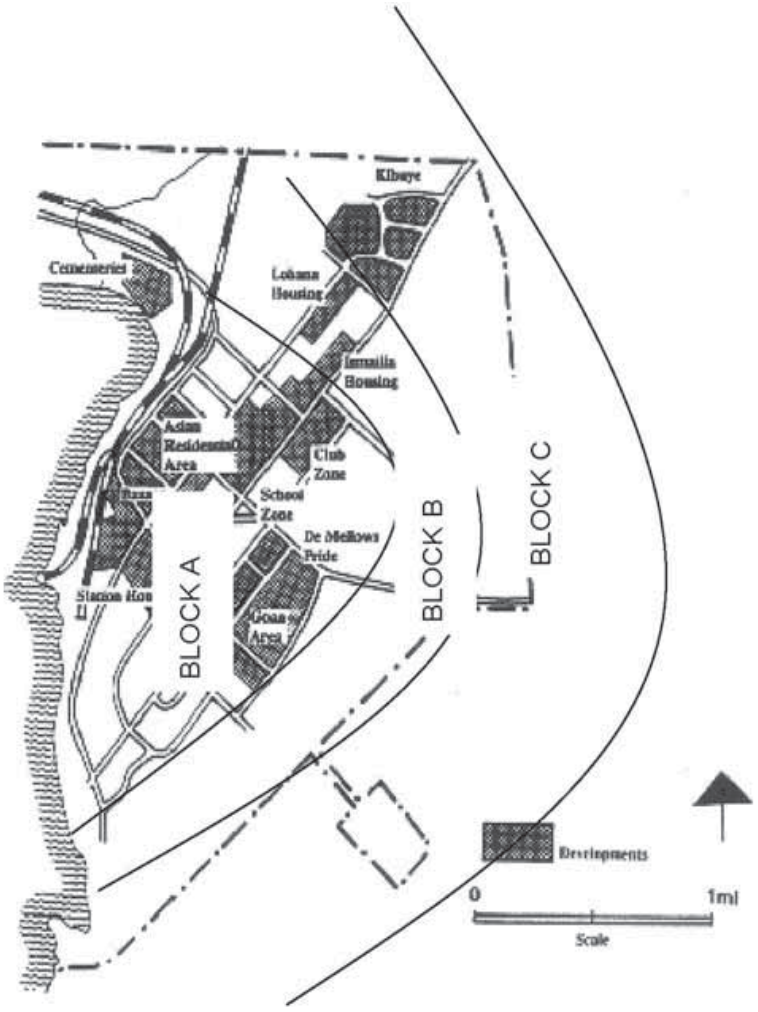
- Agriculture and Rural Development;
- Human Resource Development;
- Physical Infrastructure
- Trade, Industry and Tourism;
- Public Safety, Law and Order;
- Information Technology; and
- Public Administration.

The focus of this study will be the slum area of Kisumu town which in literature has been described as a "slum belt" with the bulk of it located along the eastern part of the municipality (UNHabitat, 2005). Furthermore a clear distinction is made between three types of informal settlements within this slum; areas that have experienced no intervention, the suburban fringe and areas that have experienced intervention. A site survey of these settlements by UNHabitat has identified eight main sub-locations (clusters): Nyalenda A, Nyalenda B, Manyatta A, Manyatta B, Obunga, Bandani, Manyatta Arab and Kaloleni (Figure 3-3). Access to basic infrastructure and amenities, quality of housing, housing densities and ultimately the level of socio-economic status is seen to vary across the eight sub-locations.

3.2. Historical Growth-Post-colonial period

The historical structural development of slum settlements in Kisumu plays a very crucial role in understanding the morphology of the slums. It depicts a trend towards the growth of a homogeneous slum belt surrounding the central business district and is seen to influence the growth of the slum belt (Figure 3-2); while simultaneously acknowledging the varying unique characteristics that define the different 8 sub-locations within the belt (Figure 3-3)-Bandani, Obunga, Manyatta A, Manyatta B, Nyamasana, Nyalenda A, Nyalenda B and Kibos (UNHabitat, 2005).

The unplanned development in Kisumu town has been attributed to the concept of the "urbanisation of the villages" (UNHabitat, 2005). This theory holds that the rapid growth along the eastern low-lying areas has been a proportional result of the influx of man-power who sought the available cheaper land and housing in this peripheral "rural" area. The initial planning of Kisumu town emulated the "garden city" model (idem); this forms the foundation for an analysis of the evidenced slum pattern to assess whether the slums have maintained a similar morphology or adapted alternative land use models.



Characteristically it took on the following structure from the colonial period:

Block A: Consisted of the port, official residences for colonial officers, government and railway headquarters, prison, police posts and hospital, together with residential areas for Indians and Europeans employed in the town.

Block B: Developed as a buffer block between Block A and C.

Block C: Was the official African residential area.

Figure 3-2: Land segregation in the old town of Kisumu

Source: (UNHabitat, 2005a)

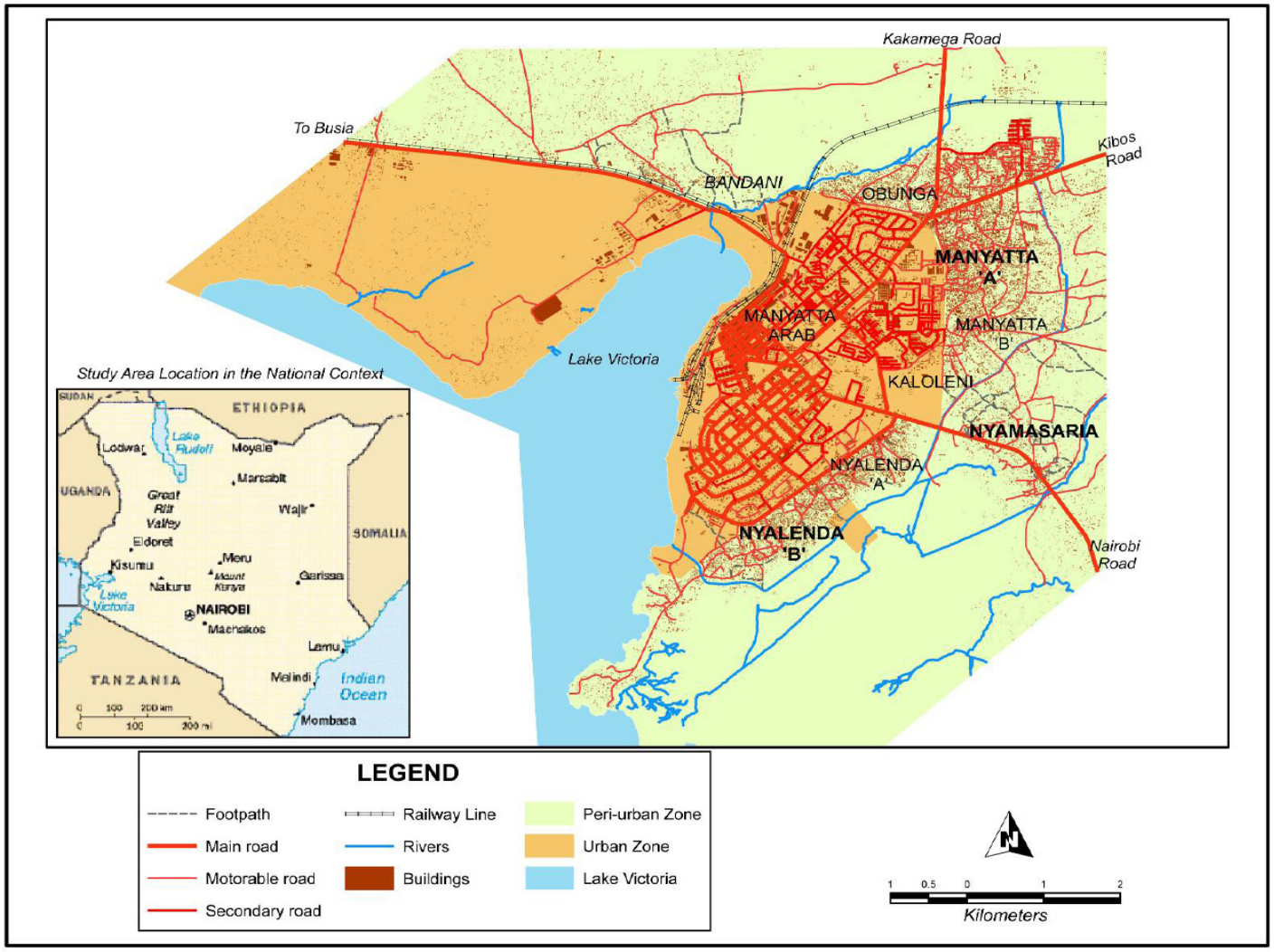


Figure 3-3: Location of peri-urban settlements (sub-locations) in Kisumu

Source: (UNHabitat, 2005b)

3.3. Locational Factors in the context of the study

UN-Habitat focuses its situation analysis of the informal settlements in Kisumu on five major themes-Land, Housing, Infrastructure, Social Services and Livelihoods (UNHabitat, 2005). Furthermore the key themes mentioned above can be linked to the context of "historical amenities" (Yonemoto, 2007) that have contributed to the growth of the slums. In the scope of this study, the locational factors adapted from the thematic framework of UNHabitat (2005b) were restructured into two thematic categories; socio-economic and physical factors (Figure 3-4).

The definition of these categories is driven by the type and descriptive role of the data that was used in the analysis. Socio-Economic factors, therefore, are thus termed because they connote an individual's purchasing power and can be obtained from socio-economic data and household surveys. Physical factors on the other hand are attributes that were drawn from image interpretation and contribute to describing the physical and spatial traits of the respective sub-locations. As acknowledged in a previous section, local solidarity networks are important locational factors that create opportunities for slum dwellers, however, due to the limitation in the type of data this factor will not be considered.

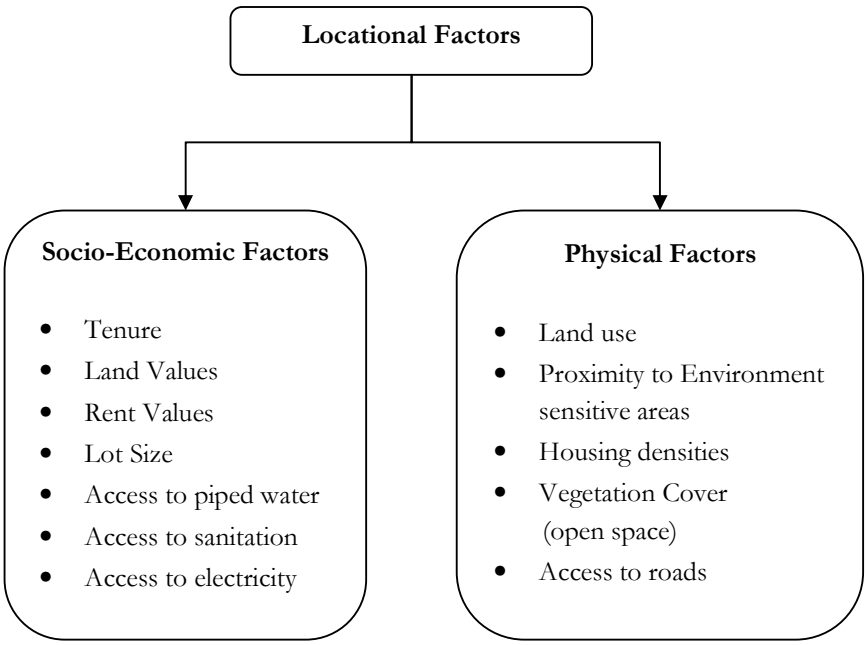


Figure 3-4: Locational Factors

From the above, a selection of the most influential factors-tenure, proximity to main roads and a major water source; have been focused on in the discussion on inter and intra variation of slums and the review of policy implication. The basis for the selection of these factors is:

- Predominance of private ownership of land in the slums of Kisumu; over 80% privately owned (Government of Kenya, 2010), contrary to most slum settings where slum dwellers are often squatting on public land;
- Difference in road patterns between the case study sub-locations-Manyatta 'A' and Nyalenda 'A'; and

- Presence of a major water source covering over 50% of Kisumu's total area base of 417km^2.

3.4. Policy intervention

The Slum upgrading of Kisumu slums is a major ongoing program supported by various institutions. The situation analysis on informal settlements in Kisumu (UNHabitat, 2005b) identifies and classes these partners into four main categories:

- Kisumu municipal council and Central government;
- Civil society organisations-local and international NGO's;
- Donor agencies; and
- Private sector.

Kisumu town has been one of the beneficiaries of the collaborative initiative between Government and UNHabitat. The Kenya Slum Upgrading Programme (KENSUP) was initiated to improve the livelihoods of slum dwellers (UNHabitat, 2005b). This has also been supplemented by other initiatives inclusive of which are:

- Kisumu East District Development Plan;
- CDS-City Development Strategy;
- LASDAP-Local Authority Service Delivery Action Plan;
- Urban Matters-Millennium Cities Initiative and CORDAID;
- USAID and Migosi site and service schemes;
- Kaloleni and Manyatta Arab upgrading schemes;
- Slum dwellers' initiatives; and
- Civil Society Organisations (CSO) initiatives

An in-depth review into schemes such as these enlightened the researcher on their impact on specific forms of deprivation.

3.5. Summary

In this chapter the main aspects of the study area have been elaborated with specific emphasis on the selection of the locational factors relevant to the study area. Elements of this section will be referred to in the following chapters as the assessment of the impact of locational factors on inter and intra variation of the slum pattern and deprivation is undertaken. This section also introduced the need to comprehend the role of the diverse upgrading programs in the review of policy implication.

4. METHODOLOGY AND DATA COLLECTION

This chapter elaborates the selected methodology for data collection and analysis undertaken during the research process. As summarised in the research design in Figure 1-2; this entails the three key phases: pre-fieldwork, fieldwork and post-fieldwork.

4.1. Pre-fieldwork phase:

This phase focused on secondary data, especially collection and review of preliminary literature to enable the researcher obtain an insight into the study area. This was supported by analysis of GIS data, satellite imagery and socio-economic data provided by ITC. This facilitated the selection of the techniques for the collection of supplementary data during the fieldwork phase. The case study approach was adopted.

4.1.1. Motivation for selecting case study approach

Emphasis is placed on the importance of the case study/descriptive approach as one that allows for general theories to be drawn from a specific situation (Goddard & Melville, 2001). While applicable to a complex situation, the case study approach also provides room for comparison of selected case study areas to see if general trends emerge.

Limited time and access to field work has been one of the foremost justifications for the case study approach (Stake, 1995), however also highlighted is the advantage of selecting cases which are typical or representative of other cases. In addition, in the selection of the case study approach importance was given to;

- Need to maximise what we can learn (from a specific case); and
- Consideration of the uniqueness and contexts of the alternative selections;

In the mind set of maximising fieldwork time, information access and bases for comparison, the researcher made an intuitive selection of case study areas within the Kisumu slum belt. The assumption is that the eight sub-locations within the slum belt would adequately be representative of each other in terms of their shared characteristics as slum settlements. In light of this, the initial selection of two case studies was based purely on the differentiation of areas in reference to the policy intervention vis a vis those that have not experienced intervention; in which context Manyatta 'A' and Obunga were selected respectively.

It is however important to note that during the fieldwork phase the initial case study areas were adjusted according to feedback obtained from key informant interviews. The resulting modification resulted in the selection of Manyatta 'A' and Nyalenda 'A' sub-locations respectively (Figure 3-3). The sites were selected because:

- They are both priority locations slated to benefit from a diversity of upgrading programmes linked to our locational factors (NODALIS Conseil, 2009); and
- Implementation of these programmes provides a possibility for future research with emphasis on monitoring and evaluation of policy implication.

4.1.2. Image classification

Analysis of classified temporal images has previously contributed to research into urban growth and slum pattern in varying ways (Sudhira, et al., 2003). Using Maximum likelihood, supervised classification of the GeoEye 2009 (Table 4-1) defined three main land uses-built up, bare land and vegetation. Due to misclassification of land uses caused by similar reflectance values the area covered by roads was classified under 'bare land'. This supported the researchers pre-knowledge on the growth pattern of the study area and was further verified during the ground truthing exercise and review of the Kisumu Conceptual Plan.

Table 4-1: Metadata for GeoEye 2009 image of Kisumu town.

Image type	**PAN/MSI**
Creation date	**23rd July 2009**
Sensor type	**Satellite**
Sensor name	**GEO EYE-1**
Resolution	**.50 meters**
Map Projection	**Universal Transverse Mercator**
Datum	**WGS84**

4.2. Fieldwork Phase

A crucial part of the study was the collection of relevant data to support the exploration of the research problem. In this case both primary and secondary data were collected during the fieldwork phase[3]. The acquisition of this data required the use of various data collection methods as elaborated below:

4.2.1. Data collection techniques

Primary data was collected by the researcher from the specific case study areas mentioned above and was obtained through the following methods: key informant interviews, focus group discussions, participant observation and household surveys. These methods provided the researcher ample opportunity to acquire a good insight into the local context. The household survey as stated above constituted the supplementary socio-economic data required to validate the assumption laid out during the development of the research problem. The scope of the survey was the selected sub-locations-Nyalenda A and Manyatta A and was structured along the smallest administrative unit (the village).

At this stage secondary data available to the researcher included literature on previous related researches and projects, socio-economic data from the Pamoja Trust socio-economic mapping exercise, GIS data and satellite imagery (GeoEye-2009) provided by ITC. The Pamoja Trust enumeration data was provide in two types spatial data that covered the extent of the study area and a partial socio-economic database for 2005. Socio-economic data for 2010 collected during the fieldwork only covered the study area of Manyatta 'A'; however socio-economic data from both time series lacked a complete link to the spatial data.

The Pamoja Trust enumeration of 2010 was collected using a comprehensive questionnaire that was structured along the following sections:

- Introduction of the area and enumerator;
- Introduction of the respondent-gender, age, role in the household;

[3] Researcher was able to benefit from collaboration with fellow student Roberto Julio Pereira; which facilitated maximisation of resources and sharing of ideas on how to execute the data collection. Sections of the fieldwork reporting are thus acknowledged as shared data sources and processes and will therefore be comparable (Pereira, 2011) .

- Housing structure-ownership, type, size, construction materials;
- Access to services-water, sanitation, garbage disposal, health services and energy use;
- Income and expenditure-Development needs and priorities.

The researcher however focused on variables pertinent to the construction of the slum index as a measure of deprivation (Figure 4-6). As a composite index, it is derived from a combination of five individual indicators. The value range for the index is from 0-5 with the ascending order indicating higher levels of deprivation. In this case it can be inferred that a household, neighborhood or analytical zone with a slum index value of 5 has a higher "slumness" than one with an index value of 3. It also suffices to conclude that entities with a slum index of 0 are not considered as slums.

The field work phase was also used to find solutions to various limitations to the available data. These limitations included the lack of a spatial link to the socio-economic data and the need for boundaries at the lowest administrative level.

4.2.2. Key Informant Interviews

Key Informant interviews were specifically beneficial in providing further insight into the study area, revision of the selected case study areas and redesigning of the questionnaires. The selection of the appropriate informants was carried out using the non-probability method of snowball sampling technique. Recognised as one of the most commonly used non-probabilistic sampling techniques for qualitative research, it provides easy access to well versed informants' (Gray, et al., 2007). In this approach all referrals were initiated from our first point of contact from the Millennium Cities Initiative (MCI).

A diverse group of key informants was identified using this approach and the choice of the interviewees always took into account the research questions. The informants included:

- Academia such as the Deputy Assistant Dean of Maseno University who provided insight on previous planning practices in Kisumu, upgrading schemes and the highlighted the Universities contribution to the planning process;
- Government officials from the Central and Local Government-provincial physical planner, town planner, district documentation officer, deputy head of housing department, LASDAP officer; all of whom elaborated on their roles as Government officials and especially their involvement in the slums of Kisumu. They also provided secondary data that will contribute to the research;
- Various NGO's were also consulted inclusive of which are Pamoja Trust which provided the major source of socio-economic and mapping data; Millennium Cities Initiative, CORDAID-Urban Matters and Shelter Forum who introduced their respective initiatives within the Kisumu slum;
- Lastly members of the community such as the councillors, chiefs, village leaders and elders also provided the perspective of the community as their recognised representatives.

4.2.3. Focus Group Discussions

Focus group discussions with village chiefs, elders and security officials served a multi-purpose function in our fieldwork process:

- Provided a forum for verification of information obtained from the key informants as well as collection of further information on initiatives at the village level;
- Enabled recruitment of 12 interviewers who worked as enumerators in the Pamoja Trust slum mapping and enumeration process of 2005 and 2010;
- Ensured full cooperation and security from the local leaders in the household survey exercise.

Two focus group discussions were conducted in Manyatta 'A' case study area (Figure 4-1). Both discussions took place in the Kosawo community hall where chiefs, village leaders, elders were invited to participate. Attendants at the first focus group included 1 deputy chief, 4 elders and 2 security officials; whereas the second focus group was with 6 village elders and 6 enumerators. The focus groups enlightened the researcher on initiatives at the sub-location and village level. This resulted in an invitation to attend the "Water Task Force" meeting, during which water issues were discussed with the community (Figure 4-1).

In the case study area of Nyalenda 'A', we were unable to hold focus group meetings as a result of limited time resulting from administrative requirements. These are elaborated in section 4.4 limitations of the fieldwork.

Researcher with attendants of the focus group discussions

Community members attending the Water Task Force.

Official from Shelter Forum addressing the community on safe water measures.

Figure 4-1: Focus groups and participatory observation

4.2.4. Participant Observation

The researcher was able to benefit from participant observation in two main forums;

- The "Water Task Force" meeting where members of the community gathered together to discuss problems related to water provision and treatment in their community.
- Secondly, the "Ward consultative" meeting where the local community participated in identification of priority areas for resource allocation. This is done through a participatory approach conducted by the Local Authority Service Delivery Action Plan, LASDAP.

The researcher was also able during the site visits to observe the varying ranges of housing typologies which are evident in the study area. Further elaboration into these typologies is discussed in chapter 5 in reference to the results in objective 1 (Table 5-2).

4.2.5. Household Survey and sampling strategy

Household surveys supplemented the socio-economic data obtained from the Pamoja Trust mapping and enumeration exercise. This entailed sampling of households in the selected case study areas of Manyatta 'A' and Nyalenda 'A'. The total households of Manyatta 'A' and Nyalenda 'A' constituted the "population" under study. Samples, therefore, were indicative of the population being studied and were determined by two key features; size and bias (Goddard & Melville, 2001). Large sample sizes are encouraged to ensure a correct representation of the population, where as a structured method of sampling is advised to avoid bias.

Random selection is the basic principle used to try to avoid bias in a sample (Goddard & Melville, 2001). The probabilistic method that was applied in this study combined stratified and systematic random sampling. A total of 150 samples were drawn from the socio-economic mapping data, with the sampling frame comprising of "Nyalenda A" and "Manyatta A" households as briefly summarised below in Figure 4-2. Each case study area was divided into the administrative level of village units comprising it and 15 samples drawn from each village.

The household survey was conducted in six sub units/villages of "Manyatta A" and four of "Nyalenda A" respectively with the example of Flamingo unit displayed in Figure 4-3. A combined structured questionnaire[4] was administered over a period of 7 days in total. The process was initiated with training of interviewers in each respective case study area. The training process took three quarters of the first day of survey in each respective case study area. The questionnaire administered focused more on qualitative data and particularly on aspects related to the perception of the interviewee.

The questionnaire was structured into three sections:

- **Key informant interviews**-aimed at refining the selection of locational factors and case study areas as well as obtaining background information to the study areas.
- **Focus group interviews**-targeted verification of information obtained during the key informant interviews and incorporating the perspective of the communities representatives;
- **Property owner questionnaire**-subdivided into two sections-introducing the property owner (land and house ownership data) and the second part on access to services, quality of housing, income and education background.

[4] Appended in annex.

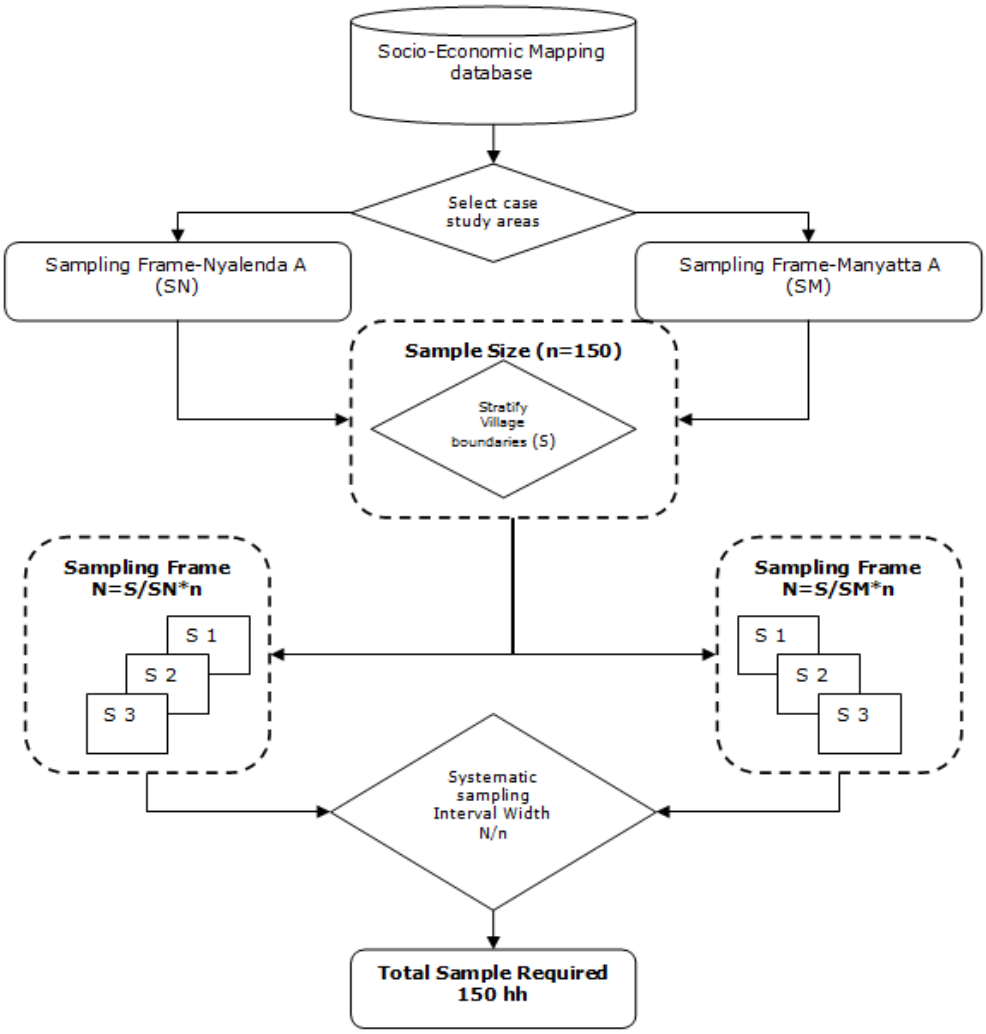


Figure 4-2: Sampling procedure for household survey.

Structured questionnaires were the most appropriate method taking into account the scope, purpose of the study, identified research objective and research questions. The choice of a structured data collection is based on several aspects:

- The questionnaire is easier to administer;
- Limitation of responses to stated alternatives makes the obtained data more reliable;
- Use of fixed-response questions limits the variability of results which;
- Facilitates the analysis and interpretation of data.

For verification purposes, the questionnaire also included some questions already covered by the secondary data.

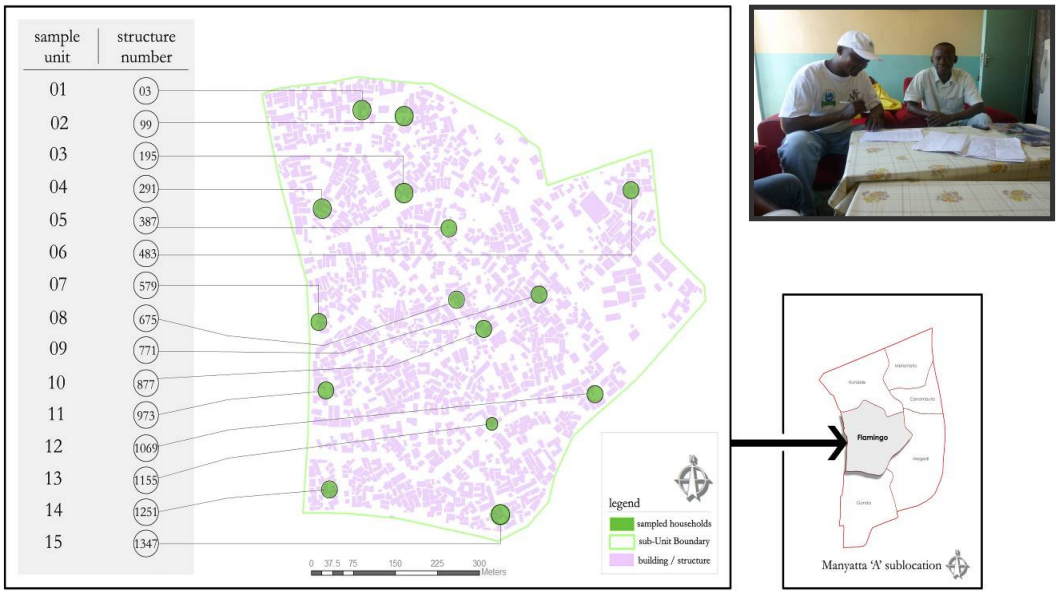


Figure 4-3: Households surveyed in Flamingo sub-unit/village; Manyatta A and an interviewer administering questionnaire to head of household.

The use of stratified and systematic random sampling ensured no bias as all strata (villages) were equally represented. However due to limitation of cost and duration required to collect an extensive sample, the sample size of 150 was not adequate to provide a true representation of the population of the case study areas. The sample of 150 returned a mean slum index of 2.31 with a standard deviation of 1.124 and a lower and upper boundary of 2.13 and 2.49 respectively at a confidence interval of 95%.

Using equation (4-1 below an estimation of a suitable sample size to achieve a desired margin of error of 5% at a confidence level of 95% yielded a sample size of 1,939 (Bernstein & Bernstein, 1999).

$$n = \left(\frac{Z \cdot S}{E}\right)^2 \qquad \textbf{(4-1)}$$

Where:

E is the allowable error (0.05).
z is the z score associated with the degree of confidence selected (1.96).
s is the standard deviation of the population (1.124).

The sample survey, therefore, will be used primarily to test the researcher's methodology and as a measure of comparison of "slumness" for Manyatta 'A' and Nyalenda 'A'. The analysis into the role of tenure as a locational factor will however focus only on Manyatta 'A' as a complete updated data set for 2010 is available for this sub location only.

4.2.6. Secondary Data

Secondary data obtained from various sources is used during this study; some of the data was availed through ITC prior to departure for fieldwork, however supplementary data was obtained during key informant interviews. A summary of the data collected and sources is shown in Figure 4-4.

Data	Format	Source	Year
Situation analysis of informal settlements in Kisumu	Access	ITC database	2005
Socio Economic Enumeration data	Access	Pamoja Trust	2005 to 2010
Urban Matters Enumeration Form	Word Document	Pamoja Trust	2010
Digital Map of Kenya Administrative division	GIS	ITC database	2005
Digital Map of Kisumu Informal settlements with household/structure enumeration	GIS	Pamoja Trust	2005 to 2010
Kenya Population and Housing Census	Hardcopy	KNBS	2009
Kisumu Concept Plan	Word Document	Provincial Planning Office	2010 (draft)
Kisumu City Development Strategy	Pdf	MCI	2004 - 2009
KUP Pre Feasibility Study, Final Report	Word Document	KCC Housing Dev. Unit	2009
LASDAP Project Report	Word and Excel	KCC	2009 -2010
Kisumu District Poverty Reduction Strategy Paper	Hardcopy	Kisumu District Office	2001
Kisumu East District Development Plan	Hardcopy	Kisumu District Office	2009

Figure 4-4: List of secondary data collected during fieldwork.

4.2.7. Limitations of the fieldwork process

The fieldwork process allowed the researcher an opportunity to collect primary data and supporting secondary data that is crucial to the research through interviews, participatory observation and focus group discussions. During this process full cooperation was received, however there were a few limitations faced:

- Some of the data collected was incomplete such as the Pamoja Trust enumeration data which was still being processed. In the case of Nyalenda 'A' the 2005 data set was incomplete and that of 2010 unavailable altogether;
- Differing administrative procedures in the different sub-units set back the projected timeframes for executing the household surveys;
- The survey was targeted at property owners, but obtaining them was difficult and required repeated visits to the households as most were away at work and others having relocated altogether. It was evident that a great portion of the houses were occupied by tenants. Two alternative approaches were taken to address this issue. The adjacent house was selected to complete the questionnaire, and in the definitive absence of owners the tenants were advised to answer the second section of the property owner questionnaire which was also applicable to tenants.

4.3. Post-Fieldwork Phase

The post-fieldwork phase commenced with data entry for primary data and preliminary review of all secondary data collected during the fieldwork to assess its completeness and relevance to the research objectives and questions. The analysis process therefore was structured along the three sub-objectives- slum pattern, "slumness" and policy intervention respectively as elaborated below.

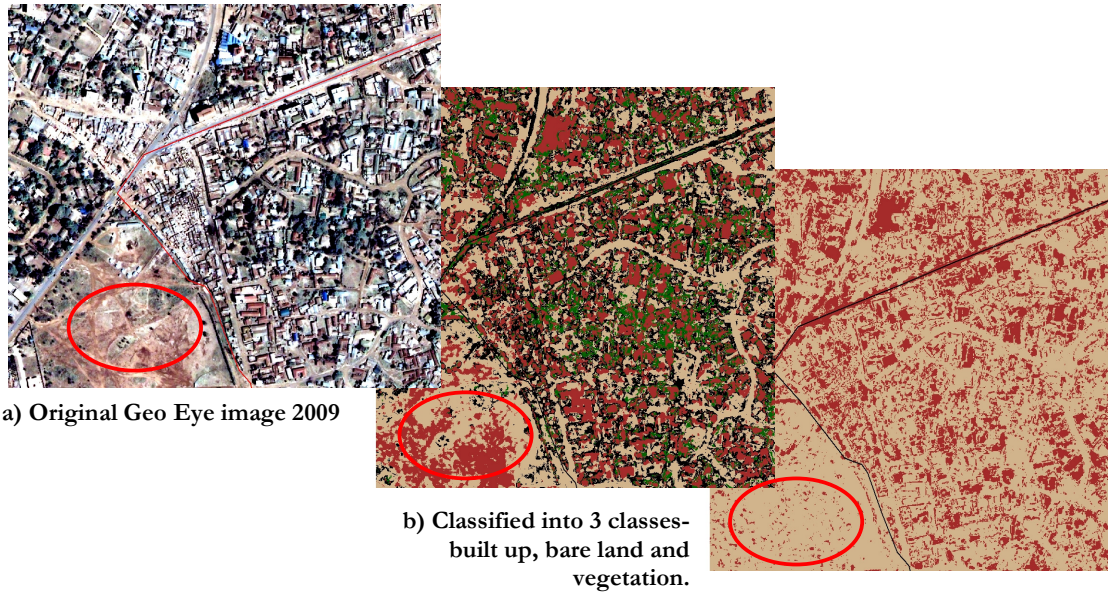
4.3.1. Analysis of slum pattern

Previous research on urban sprawl has established that slum patterns can be extracted from image analysis (Baud, et al., 2010; Bhatta, et al., 2010; Herold, 2001; Kohli, 2007; Sliuzas & Kuffer, 2008; Sudhira, et al., 2003). Furthermore they elaborate the various techniques that may be applied in the context of specific research themes. For purposes of this research the methodologies applied are categorised into three main process-visual interpretation, image classification and the use of spatial metrics respectively. The Geo-eye 2009 provided initial data for the researcher to carry out visual interpretation and image classification which were later supported by ground verification.

4.3.1.1. Image classification

The Geo-eye 2009 image was subset to select the case study areas of Manyatta 'A' and Nyalenda 'A'. Using supervised classification three land use classes were derived-built up, bare land and vegetation. The targeted three classes (built up, bare land and vegetation) were in various instances seen to overlap. This was associated to the similar reflectance values returned by all classes influenced by the variation in type and age of roofing material, type of soil and vegetation cover among others. In an effort to improve the accuracy levels of the image classification a wide range of informed classes (50) were identified and merged into the above three classes. Overall accuracy levels[5] achieved were 82% and 86% for Manyatta 'A' and Nyalenda 'A' respectively.

As indicated in the accuracy reports in the appendix, misclassification was most apparent in the classes of built up and bare land which shared reflectance values close to each other. Roads, bare land and a selection of roof types reflected similar values. In addressing the shadows that are resultant from high resolution images when classifying urban areas, shadows were classified under vegetation. The decision to classify shadows under vegetation was based purely on the fact that vegetation and shadow returned comparable reflectance values. However, this also resulted in the misclassification of the vegetation class on 8 counts. Figure 4-5 b shows instances of misclassification where bare land was initially classified as built up area and reclassification was required to rectify the error.



a) Original Geo Eye image 2009

b) Classified into 3 classes- built up, bare land and vegetation.

c) Reclassified into built up and non-built up

Figure 4-5: Images showing errors in image classification

[5] Detailed accuracy report in appendix

4.3.1.2. Visual image interpretation

Visual image interpretation used various key visual elements that guided the perception of the nature of the slum in the study area. These elements which enabled the informative view of the study area prior to fieldwork were tone, shape, size, pattern, texture, shadow, and association (Herold, et al., 2003). Most importantly in cohesion with the classified images they facilitated the extraction of roofing typologies (housing quality), road patterns and initial land use classifications.

4.3.1.3. Spatial Metrics

As established in prior chapters spatial metrics are quantitative measures that describe structures and patterns of a landscape (Herold, 2001). Aguilera, et al. (2010) introduces the use of spatial metrics in the analysis of urban growth patterns with specific focus on three main processes-aggregation, compaction, and dispersion. In the context of this study these processes are interpreted as densification, intensification and expansion. In order to assess the role of these processes in the slum pattern in the study area the researcher adapted the selected metrics applied by Aguilera, et al. (2010).

Fragstats supports the computation of over 100 metrics (de Smith, et al., 2009; McGarigal & Marks, 1995); however comparison of the pre-selection of these metrics by Aguilera, et al. (2010) to the work of other researchers has influenced the selection of the relevant metrics for the purpose of this study (McGarigal K., et al., 2002; Tsai, 2005).

Classified images of Manyatta 'A' and Nyalenda 'A' were converted into ArcGRID format, reclassified into built-up and nonbuilt-up and run through FRAGSTATS public domain software to compute the above described metrics at the class level. The metrics were calculated using:

- Standard analysis to obtain values that quantify the growth of built-up area during the period of study ultimately provided a description of the structure of slum growth in the study area.

Quantification of the complete study area (sub-locations) was limited by the presence of "no data" values outside the area boundary. These values were being computed as part of the landscape and affected the resulting spatial metric values. To address this limitation, the landscape was subset to the immediate internal rectangular limit of the boundary.

Definitions and functions of the selected metrics as adopted from the FRAGSTATS software documentation are summarised in Table 4-2 below:

Table 4-2: Table of selected metrics (McGarigal K., et al., 2002)

Name and Range of spatial metric	Equation/Definition	Rationale for selection of metric/Unit of measure
1. Patch Density (PD) PD > 0, constrained by cell size.	$PD = \frac{N}{A}(10{,}000)(100)$ **N** = total number of patches in the landscape. **A** = total landscape area (m2).	**Unit: Number per 100 hectares.** Provides a measure of built-up density and supports the measure of densification in the case study area.
2. Edge Density (ED) ED ≥ 0, without limit.	$ED = \frac{E}{A}(10{,}000)$ **E** = total length (m) of edge in landscape. **A** = total landscape area (m2).	**Unit: Meters per hectare.** A measure of edges in a landscape over total landscape area. In the context of the study could be influenced by the roof shape/coverage of the different housing typologies.
3. Contagion Index (CONTAG) 0 < CONTAG ≤ 100	$CONTAG = \left[1 + \frac{\sum_{i=1}^{m}\sum_{k=1}^{m}\left[(P_i)\left(\frac{g_{ik}}{\sum_{k=1}^{m} g_{ik}}\right)\right]\cdot\left[\ln(P_i)\left(\frac{g_{ik}}{\sum_{k=1}^{m} g_{ik}}\right)\right]}{2\ln(m)}\right](10$ **Pi** = proportion of the landscape occupied by patch type (class) i. **g_{ik}** = number of adjacencies (joins) between pixels of patch types (classes) i and k based on the double-count method. **m** = number of patch types (classes) present in the landscape, including the landscape border if present.	**Unit: Percentage** Shows level of spatial aggregation of patch types. Supplements Patch Density in that it provides a value of clumpiness.
4. Patch Richness Density (PRD) PRD > 0, without limit	$PRD = \frac{m}{A}(10{,}000)(100)$ m = number of patch types (classes)present in the landscape, excluding the landscape border if present. A = total landscape area (m^2).	**Units: Number per 100 hectares** Introduces the measure of diversity by quantifying the number of different patches within a landscape.

4.3.2. Analysis of "slumness"

Poverty has in recent research been acknowledged as a multi-dimensional facet and consequently has been measured using a variety of indices. Baud et al., (2010) uses the index of multiple deprivations (IMDs) to examine poverty from the aspect of the livelihoods approach whereas Weeks et al., (2007) looks at defining neighbourhoods from the level of their respective "slumness". Despite their distinct approaches they share a common source of indicators of poverty drawn from the UN-Habitat definition of slums to form these indices (Martínez, et al., 2008). Furthermore they both acknowledge the element of heterogeneity in the manifestation of poverty in slums. The slum index is selected as the measure of

deprivation because it focuses principally on the neighbourhood structure as a means of delineating poverty.

Using socio-economic data from the enumeration and mapping by Pamoja Trust (2005 and 2010) and the household survey by the researcher; Week's composite slum index at household level and mean slum index for each analytical zone (village administrative level) was calculated. The enumeration data of 2005 is used as the base year in constructing the slum index despite the absence of two indicators-quality of housing structure and overcrowding. The data is still able to support a comparative analysis between the index drawn from the enumeration of 2010 and the researcher's household survey.

As a composite index, the slum index is derived from a combination of five individual indicators (Figure 4-6). The value range for the index is from 0-5 with the ascending order indicating higher levels of deprivation. In this case a household, neighbourhood or analytical zone with a slum index value of 5 would be more of a slum than one with an index value of 3. It also suffices to conclude that entities with a slum index of 0 are not considered as slums.

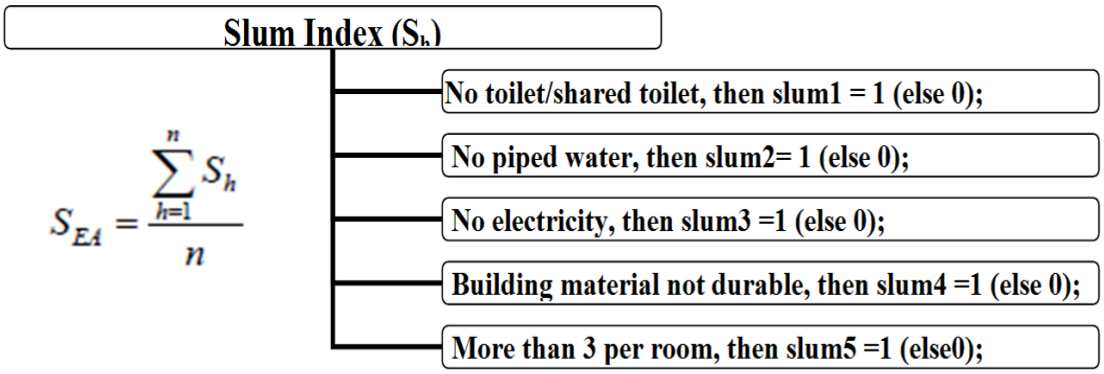


Figure 4-6: Indicators that form the composite Slum Index; equation for the mean slum index (Weeks, et al., 2007)

4.3.3. Measure of association between locational factors and individual indicators

For elaboration of the relationship between the selected locational factors, we focused on the impact of tenure on the individual indicators that feed into the composite index. The use of Pearson's chi-square test enabled the measure of association between these categorical variables. The computation of the chi-square entailed the following steps:

- Creation of a two way table to organise the data;
- Statement of the hypothesis;
- Calculation of the expected count cells and chi square (X^2) statistics-(X^2 values, degrees of freedom and significance level); and
- Either by referring to the chi-square critical values or directly from comparing the p-value measure to the set significance level (α); draw conclusions on the association between the variables.

4.3.4. Analysis of policy intervention

The analysis of policy is done through descriptive review of policy documents such as the Kisumu Concept Plan, National Land Policy, Zoning guidelines of Kisumu Municipality and LASDAP report. Implication of the policies and regulatory tools described in these documents are inferred from the results

of Chapters 5 and 6 on slum pattern and deprivation. Descriptive analysis of quantitative data used in the stated chapters is used to assess the impact of policy on locational factors.

4.4. Summary

This chapter has adapted methodologies from literature review in chapter two and adapted them to the context of this study. These methodologies include satellite image analysis, development of the slum index and measurement of associations using the chi-square test. All future analysis in Chapters 5 and 6 will be based on the techniques identified in this chapter.

5. DYNAMICS OF SLUM GROWTH AND PATTERN IN KISUMU-MANYATTA 'A' AND NYALENDA 'A'

This chapter discusses the results obtained from image analysis-GeoEye 2009 of the case study areas. Furthermore it elaborates on the adequacy of available data and applied methodologies to address objective 1. Remote sensing techniques such as image classification, visual interpretation in combination with computation of spatial metrics are used to describe the slum pattern of Kisumu slum (Manyatta A and Nyalenda A). Consequently a comparative analysis of the slum pattern using review of the land use models/ structure plans and housing typologies observed during fieldwork is made.

5.1. Image classification

Image classification yielded three classes' built-up, bare land and vegetation for both case study areas-Manyatta A and Nyalenda A as depicted in Figure 5-1. Subsequently the image was converted into grid format for purposes of extraction of spatial metrics to describe the spatial pattern in FRAGSTATS software. During this process reclassification into two classes was carried out; built-up and non built-up[6]. The delineation of the land uses in the classified image allows us to observe the structure of the slum and later supports the extraction of spatial metrics to quantify this pattern.

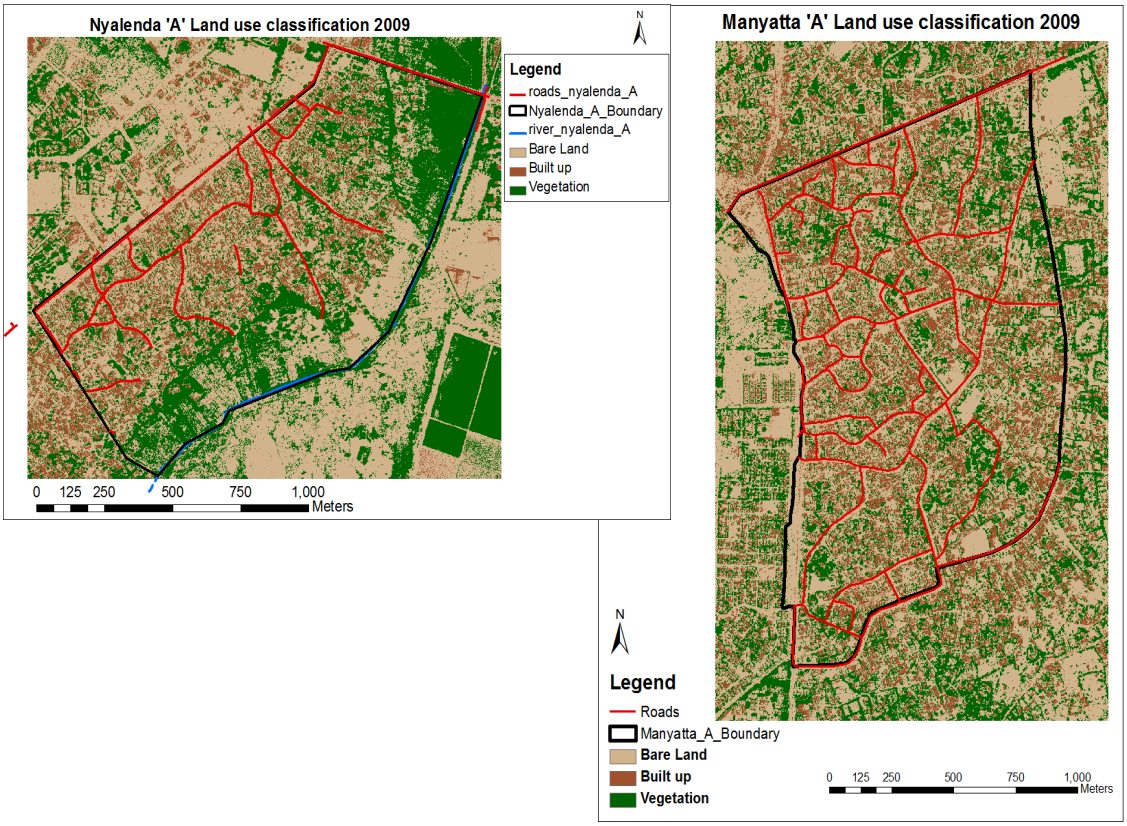


Figure 5-1: Classified images Manyatta 'A' and Nyalenda 'A'

[6] Constitutes bare land and vegetation.

5.2. Spatial metrics and slum pattern

To support the discussion on the pattern of slum growth in the case study area, the converted grid format image was run through FRAGSTATS to obtain the spatial metrics on built-up area as indicated in Table 5-1 below.

Table 5-1: Spatial metrics at landscape level on built-up area of Manyatta A and Nyalenda A (2009)

STUDY AREA	PD Number per 100 hectares.	ED Meters per hectare.	CONTAG Percentage	PRD Number per 100 hectares
Manyatta A	652.09	974.29	16.25	1.71
Nyalenda A	569.71	604.31	41.97	1.97

A comparative analysis of the different metrics allows us to get an insight on the variation in the slum pattern between Manyatta 'A' and Nyalenda 'A'. While the results obtained do not indicate a very wide range in variation between the two areas, we are still able to identify the unique patterns. The higher values of Patch Density (PD)-652.09 and Edge Density (ED)-974.29 suffice to show higher levels of fragmentation in Manyatta 'A' than in Nyalenda 'A'.. The greater patch density could also be interpreted as an indication of spatial heterogeneity. The premise would be that with development of new patches is the opportunity for a wider disparity of socio-economic and spatial characteristics such as deprivation levels and housing typologies. On the other hand both the Contagion Index (CONTAG) and Patch Richness Density (PRD) support the above theory by displaying that the concentration of the built-up area in Nyalenda 'A' is more clumped. The contagion index of 41% for Nyalenda 'A' especially shows higher levels of aggregation of patches in this landscape.

In linking the spatial metrics to the selected locational factors various observations are made. Whereas both Manyatta 'A' and Nyalenda 'A' have faced the same conditions during the rural-urban transition process as a result of the boundary extensions; the presence of a similar tenure system and absence of zoning guidelines have manifested into different slum patterns. The presence of a better and structured road pattern in Manyatta 'A' acts as driving force for growth along the road layout hence the dispersion of growth. In the same principle the growth in Nyalenda 'A' is seen to cluster along the main highway separating Nyalenda 'A' from Milimani area. However, contrary to the impact in Manyatta 'A' the absence of supplementary structured road networks within Nyalenda 'A' has resulted in the aggregation of built up area along this main highway. Furthermore this aggregation could also be attributed to the proximity of Nyalenda 'A' to the river and swamp which inhibits expansion into the lower part of the area. The presence of the combined natural-cultural[7] locational factors (main road and the river/marsh) creates attraction and repulsion forces resulting in the clumpiness.

5.3. Land use models, plans and slum pattern

The growth of Kisumu town has occurred in various stages from 1908 to date, each stage impacting on the type of growth (Figure 5-2). Understanding this phased growth lent perspective to the analysis of slum pattern in the case study areas of Manyatta A and Nyalenda A.

[7] Derived from the combination of various factors into three broad categories-natural, cultural and combined natural-cultural factors (Agnihotri, 1994)

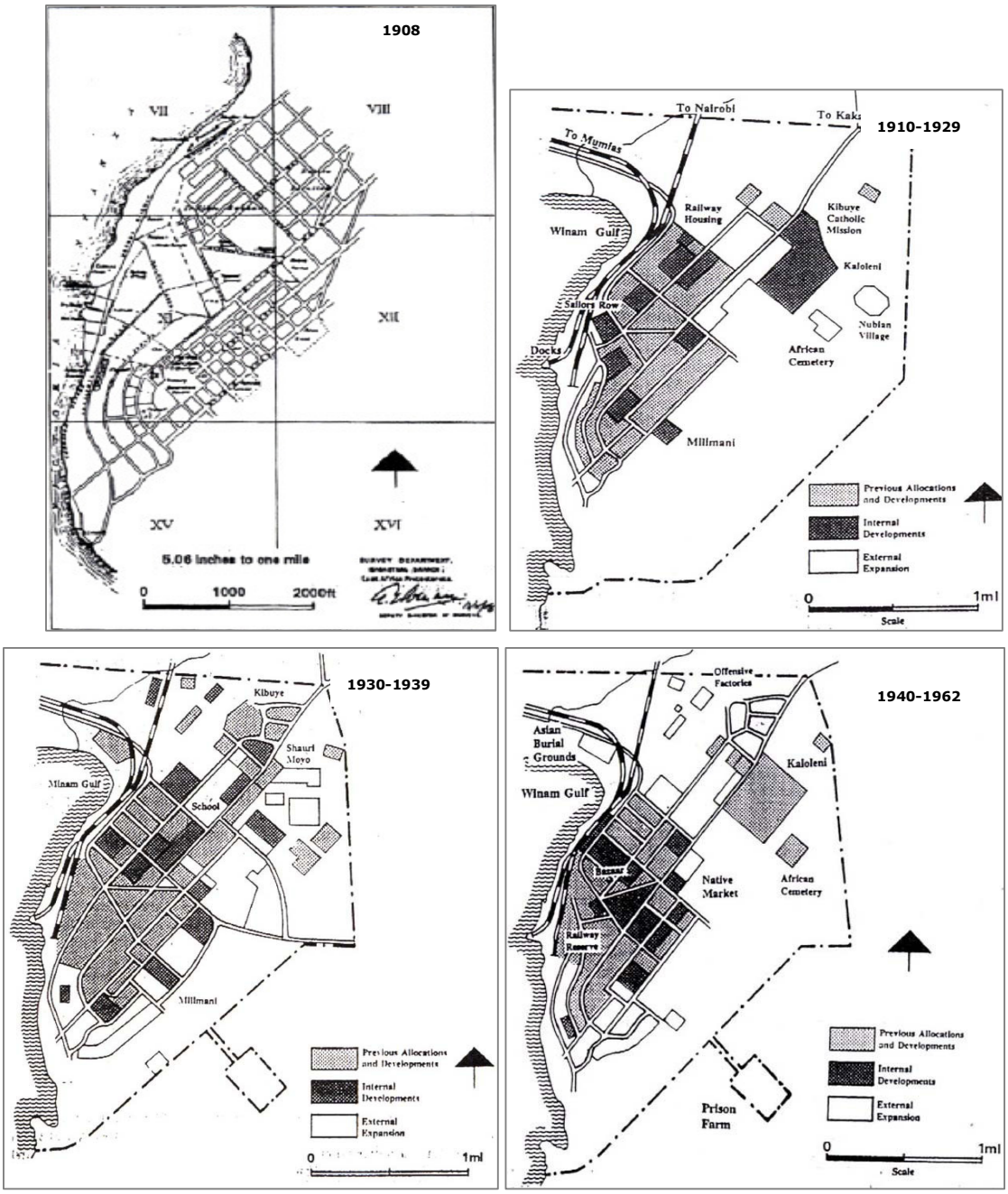


Figure 5-2: Key phases of Kisumu urban structure changes-1908-1962 (Okonyo, 2008)

Originally Port Florence in 1898, Kisumu Town became a township in 1903 following the construction of the Uganda-Kenya railway. In 1902 it took on the form of the typical grid pattern structure, with the railway stations in the vicinity acting as catalysts to its growth. Similar to Hoyts sector model, the town grew along culture specific sectors which were then further defined into race specific neighbourhoods. Over the period of 60 years as the township grew, concentrated development was encouraged; however, with the extension of the boundaries in 1968, growth in the form of urban villages became predominant (Figure 5-2). This was supported by the inclusion of differing categories of tenure-leasehold and freehold. The extended boundaries were considered rural and not subjected to the rigorous urban planning and

zoning guidelines that the city centre abided to. The area of Kisumu town was then further expanded in 2000 to incorporate the Kisumu District boundary.

As identified earlier in section 3.2, Kisumu town primarily adopted the green garden model, however expansion of the town boundaries into availabile rural land that was not within the direct control of the municipality resulted in the development of the slum belt. Over time the development along this periphery could be characterised as expansion, with unplanned development taking over open spaces, however in recent years this expansion has been limited to the arbitrary slum administrative margins (sub-locations). This has resulted in the alternative densification and intensification the sub-locations.

The extension of the boundaries and ultimate merge of different forms of tenure is seen to impact on the change in type of housing typologies in the slum areas that developed along the periphery. These areas initially developed as villages with homesteads spread apart, but overtime as the villages urbanised to embrace the new urban status; we see a mix of housing typologies which are believed to contribute to variation in slum growth and deprivation. These housing typologies are further discussed in 5.4 below.

5.4. Housing typologies in defining the character of a slum

Housing typologies have been illustrated using a combination of satellite images and ground verification (Baud, et al., 2010); and unique profiles defining each typology developed. Using visual interpretation delineation of housing typologies according to roofing patterns was done. Ground verification facilitated the development of profiles for each typology. In developing these profiles a link to tenure type was established and factors into the selection of tenure as a key locational factor in the slum growth and deprivation in the study area. A review of the Kisumu housing typologies yielded three main typologies as defined in Table 5-2 below. Important to note is that these housing typologies also lend to the definition of the type of development occurring-expansion, densification and intensification. Where family housing and rental housing contribute primarily to the expansion and densification process, mixed used housing is influential in the densification and intensification process. Mixed use housing is attracted to major roads and as a result is limited in its placing options with most buildings replacing already existing developments along the main roads. Family and rental housing on the other hand seeks any available land within the slum area without prioritisation.

5.5. Heterogeneity in spatial pattern

In assessing heterogeneity, we draw back to the three main elements introduced in this chapter; spatial metrics, land use models and housing typologies. Each of these elements in their individual capacity has served to indicate a level of heterogeneity either within or between the case study areas of Manyatta 'A' and Nyalenda 'A'. However in this chapter we establish the link between the individual elements.

Using the spatial metrics we were able to identify that the growth pattern in Manyatta 'A' is more dispersed than in Nyalenda 'A' and hence more heterogenic in this aspect. Furthermore the association to the role of the selected locational factors as the drivers of this pattern was highlighted. However, with reference to the housing typologies we realised both inter and intra variation as the housing typologies differ in manifestation both within and between the two sub-locations. In Figure 5-3 we summarise the link and their resulting impact.

Reference is drawn to the classification of Agnihotri (1994) in Figure 2-1 where he classifies the character of a slum from a multi-dimensional approach: legal status, tenure of occupancy and type of habitation. We apply the same theorem to highlight the angles of variation in the slum structure identified in this chapter-tenure of occupancy, housing quality and typology.

Table 5-2: Housing typologies

Housing Typology	Descriptive Profile	Roofing/Ground pattern	Housing image
Family Housing	• Square shaped roofing • Lower density • Unplanned green space/open space • Not dependent on road infrastructure • Village/Clan homesteads • Single door entrance into housing • Family owned and resident • Primarily temporary and semi-permanent • Mostly unauthorised development	 	 
Rental Housing	• Rectangular shaped roofing • Higher density • Lack of green space/open space • Not dependant on road infrastructure • Multiple door entrance into housing • Partial family residing/complete residential rental units • Primarily temporary and semi-permanent • Mostly unauthorised development	 	 
Mixed Use Housing	• Square shaped roofing • Higher density • Lack of green space/open space • Close to major roads • Shadow effect in RS imaging • Commercial and residential use (primarily rental) • Permanent construction • Authorised development	 	 

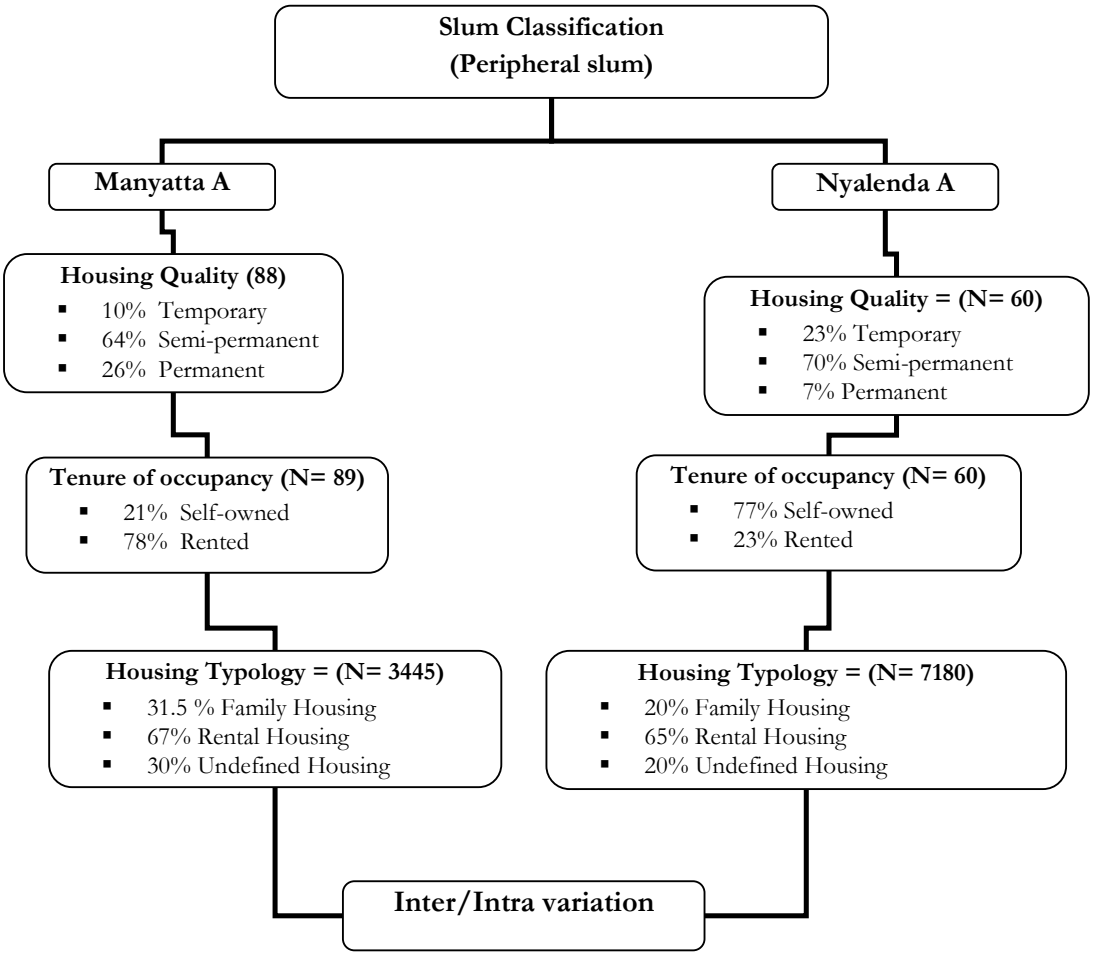


Figure 5-3: Classification of Manyatta 'A' and Nyalenda 'A' as adapted from Agnihotri (1994).

For housing quality and tenure of occupancy we draw from the household survey whereas for housing typology we rely on the Pamoja slum mapping and enumeration for its comprehensiveness in this descriptive factor.

In substantiating the values obtained from the household survey data we were able to identify a similar trend in the percentages drawn from the Pamoja Trust data set of 2010 for Manyatta A (N=4166). Housing Quality was 10%, 43% and 47% for temporary, semi-permanent and permanent respectively where as for tenure of occupancy 21% were self-owned and 79% rented.

5.6. Summary

In summary, therefore, this chapter showed evidence of inter and intra variation in slum pattern as portrayed in the results above from the analysis and review of the spatial metrics, land use models/plans and housing typologies. In chapter 6 we explore the socio-economic data to see if spatial variation is also present in the manifestation of deprivation.

6. LOCATIONAL FACTORS, SLUM PATTERN AND DEPRIVATION

Chapter 6 focuses on the development of a slum index as a measure of deprivation. It further elaborates on the association between tenure; as one of the selected locational factors impacting deprivation patterns in Kisumu slums, and the individual indicators that form the index. Lastly it reviews aspects of policy to establish the implication on slum pattern and deprivation. This chapter addresses objectives 2 and 3.

6.1. Slum Index as a measure of deprivation

The selected indicators highlighted in Figure 4-6 were amalgamated to derive the slum index for both year 2005 and 2010. This index was assessed at three aggregate levels: household level[8], village sub-units and slum sub-locations.

6.1.1. Slum index in 2005

The slum index was based on the socio-economic data from the Pamoja Trust Kisumu enumeration and mapping database of 2005. However, due to limitation in the scope of the data, indicators 4 (housing quality) and 5 (overcrowding) were not applied and the value range was then adjusted to 0-3 (Figure 4-6). This was considered during comparative analysis of the slum index derived from the researcher's sample household survey and Pamoja Trust data for 2010 which constitutes all indicators and therefore has a value range of 0-5.

Table 6-1: Descriptive statistics on the slum index for 2005: a) Plot level, b) Sub-location Manyatta A, c) Sub-locational Nyalenda A.

a) Household level for the entire slum belt of Kisumu

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Slum index	11466	.00	3.00	1.6968	.66922
Valid N (listwise)	11466				

b) Sub-location level-Manyatta A

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Slum index	1093	1.00	2.00	2185.00	1.9991	.03025
Valid N (listwise)	1093					

c) Sub-location level-Nyalenda A

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Slum index	3129	1.00	1.00	3129.00	1.0000	.00000
Valid N (listwise)	3129					

[8] Socio-economic data was recorded at plot level, with plots holding multiple households being registered under one property owner, but individually represented.

Table 6-1 above shows an overall mean value of 1.69 and a standard deviation of 0.66 for all households which comparative to the sub-location means of 1.99 and 1.00 for Manyatta 'A' and Nyalenda 'A' respectively show that Manyatta 'A' has a higher slum index than the average household. This can be attributed to the individual indicators that feed into the slum index; Manyatta 'A' returns a percentage of 99.9% of the households with both no water and no electricity. Nyalenda 'A' on the other hand is seen to score highly on both these indicators with 100% accessibility to water and electricity of the homesteads.

Despite the lack of all indicators in the 2005 enumeration, we still refer to this data as a useful base data set for comparison with the current year under study-2010.

6.1.2. Slum index in 2010

In lieu of a comprehensive socio-economic database, the slum index of 2010 is drawn from the sampled households surveyed during the researcher's fieldwork. A total of 150 households were surveyed, however two of these were rendered void due to partially completed questionnaires as a result of absence of informed respondents. The sample of 150 households is not recognized as representative of the entire population, but however serves the researcher's purpose of indicating inter and intra variation.

Table 6-2: Slum index and individual indicators drawn from the household survey 2010

Administrative Level[9]	Slum Index	Individual indicators (%) (Figure 4-6)				
		S1 Access to toilet	S2 Access to water	S3 Access to electricity	S4 Housing quality	S5 Overcrowding
1. Manyatta A:	**2.35**	**4**	**93**	**51**	**39**	**48**
a) Metameta	2.79	7	100	57	50	64
b) Magadi	2.50	7	100	43	57	43
c) Gonda	2.60	7	80	53	33	87
d) Flamingo	2.50	100	100	71	36	43
e) Konambuta	1.87	0	80	40	40	27
f) Kondele	1.94	6	100	44	19	25
2. Nyalenda A:	**2.25**	**5**	**52**	**53**	**48**	**67**
a) Kanyakwar	2.33	13	47	60	53	60
b) Wadhare A	2.29	7	21	71	50	79
c) Wadhare B	1.69	0	75	18	31	44
d) Libeto	2.73	0	60	67	60	87

Assessment of the slum index and the most influential indicators (S2, S3 and S5) enables us to see spatial variation of the manifestation of deprivation both between and within the two sub-locations. Aggregation to the different levels facilitated in assessing the variation as an impact of the individual indicators. The principle behind identifying neighborhoods in relation to their level of 'slumness' is in this case well depicted at the sub village level (Weeks, et al., 2007). In Figure 6-1 one can see that the variation in deprivation is not restricted to boundary but is cross cutting and creates unique neighborhoods.

[9] Administrative levels: sub-location, village unit, sub-village unit

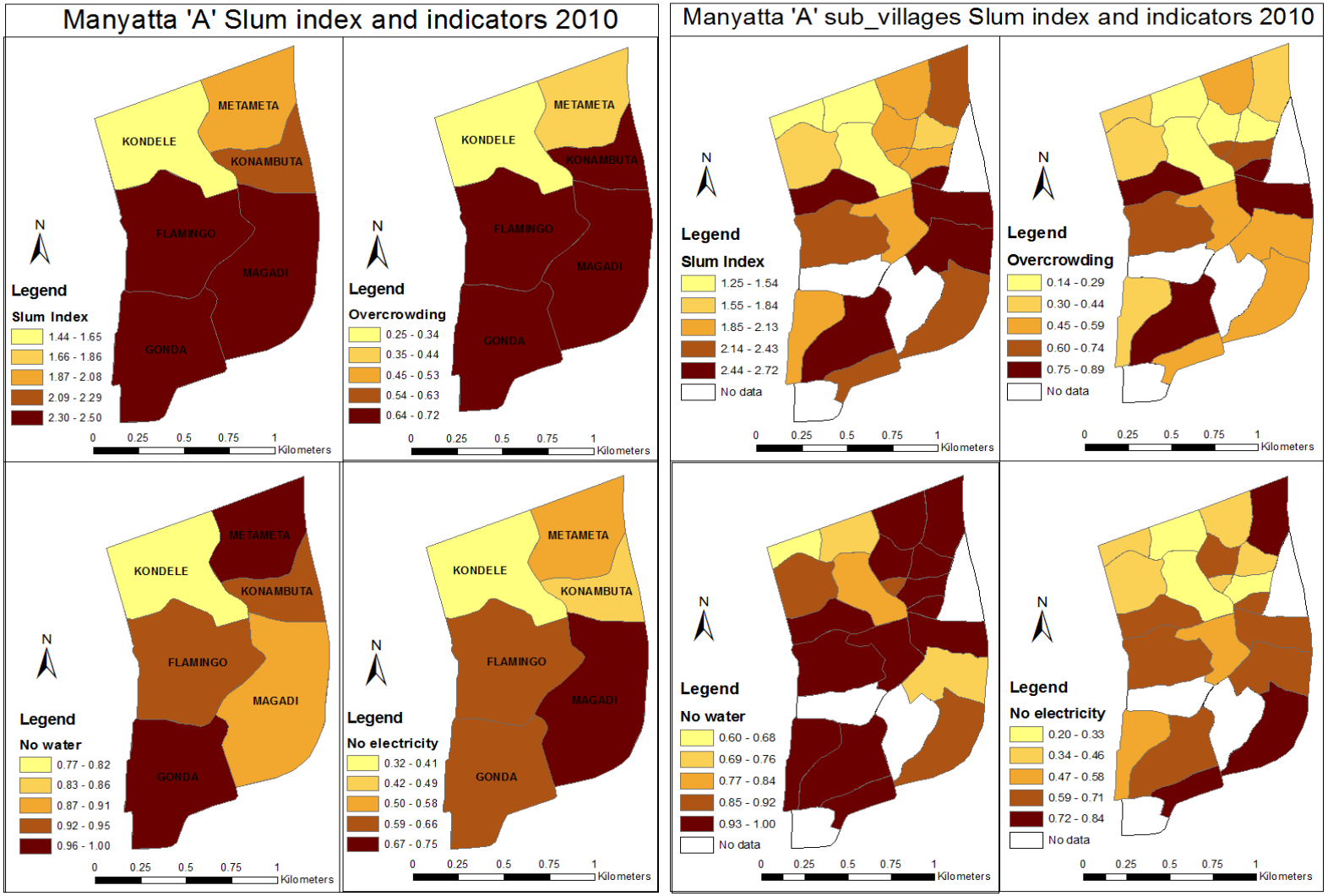


Figure 6-1: Slum index and individual indicators for Manyatta A at village and sub-village level drawn from Pamoja Trust enumeration 2010.

6.1.3. Comparative analysis of slum index values

The slum index from 2005 portrays a uniform manifestation of deprivation, however information collected from respondents during the household survey and the 2010 survey of Manyatta 'A' indicate otherwise. This may be attributed to:

- Data collection methods used in 2005 that may differ to the techniques applied in the 2010 enumeration;
- The impact of policy intervention; or
- Change in the study population (settlement of new residents and change in economic status of existing residents).

Despite being an indicative baseline, this data set therefore does not contribute extensively to the analysis of inter and intra variation.

The slum index drawn from the household survey indicates a level of heterogeneity that is validated by the researcher's observations on ground. We take the example of indicator S2-lack of access to water, where Manyatta 'A' scores poorly in comparison to Nyalenda 'A' (Table 6-2). During fieldwork limited access to water was identified as one of the major concerns in Manyatta 'A' contrary to Nyalenda 'A' where there is positive variation in accessibility to water across the villages. The households without access to water in Nyalenda 'A' range from 27%-75%; contrary to Manyatta 'A' where 80% and over of the households are without access.

The Pamoja Trust data set and the researcher's household survey both serve to show heterogeneity in the level of slumness, however the slum index values of 1.83 and 2.35 respectively merits further discussion. Higher standard deviation values of 1.051 over 0.914 indicate more disparity in the household survey data; however this may be attributed to the limited sample size. Using the standard error of the mean (SE) for testing how well our sample is representative of the whole population would help validate the results from our household survey (Field, 2009).

It is noteworthy that the Pamoja Trust data set in its entirety has values of 0, indicating that some households do not fall under the category of a slum despite being located in a slum area-Manyatta A. It can however be inferred from the similarity in mode (2 deprivations); as it is not influenced by the variation in individual cases, that in both data sets the majority of the population is lacking in two indicators (Figure 6-2).

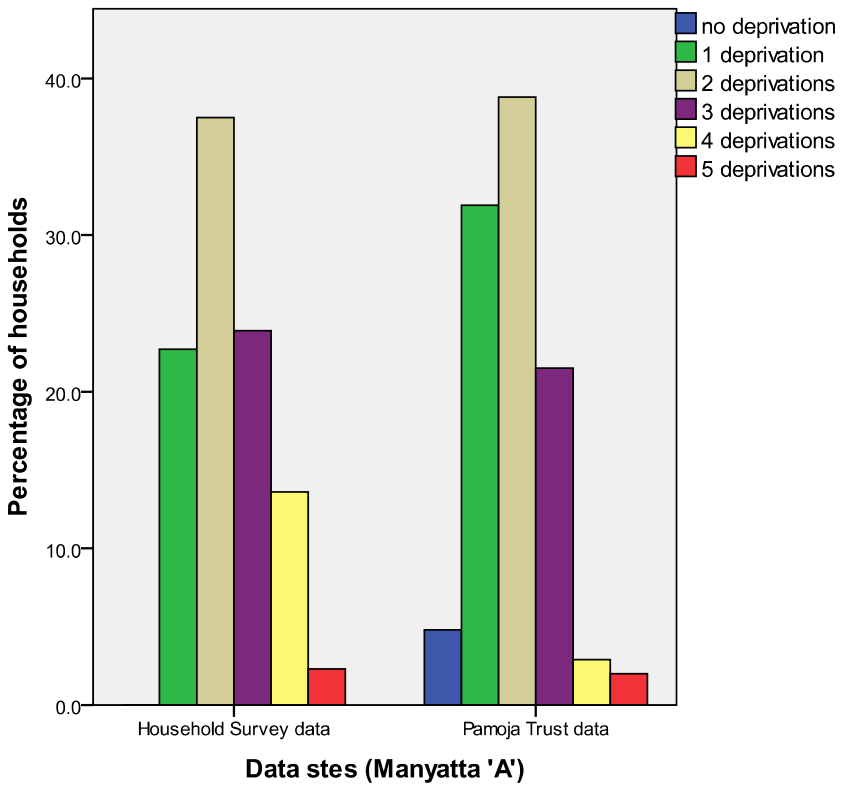


Figure 6-2: Comparison of slum index for Manyatta A: Pamoja Trust data set and Researcher's household survey (2010)

6.1.4. Impact of locational factors on 'slumness': Tenure and individual indicators

Tenure was identified as one of the key locational factors that have influenced the pattern and deprivation in Kisumu slums. In chapter 2 we introduced the concept of classifying tenure in a multi-dimensional perspective: legal status, tenure of occupancy and type of habitation (Figure 2-1); and in chapter 5 further reference is made to this classification in summary of the variation in the study areas (Figure 5-3). In this context tenure is recognized as ownership of the housing unit and will therefore refer to tenure of occupancy-self owned versus rented.

In this section we aim to assess the relationship between tenure as a key locational factor and the individual indicators that contribute to the composite slum index. To enable the evaluation of this association we apply the chi-square test along the following generic null and alternative hypothesis, applicable to all indicators:

- H_0: No association exists between indicator 'x' and house ownership.
- H_1: House owners have fewer deprivations than renters.

In establishing directionality of the relationship we hypothesize that more house owners will tend to have access to toilets, water and electricity, less overcrowding and better housing quality than renters. In addition, formulating the direction of the relationship in H_1 makes the significance test a one-tailed test so the value for Pearson's Chi squared will be halved in determining significance. The provision for the application of the one-tailed is that the actual count of deprived renters exceeds the expected count in the data set.

With supply of affordable housing being a challenge for the slum in Kisumu (UNHabitat, 2005b); the assumption is that the portion of the population that is residing in the slums under rental schemes is more disadvantaged than the property owners.

We report the chi-square statistics with "degrees of freedom and sample size in parentheses, the Pearson chi-square value[10] (rounded to two decimal places), and the significance level" (American Psychological, 2010). Significance level is set at 0.05.

6.1.4.1. Tenure and access to sanitation (toilet)

Indicator S1 highlights the households without access to sanitation (toilet). The premise is that house owners would have higher propensity to be residing in a household that has access to a toilet as they would be at liberty to construct at will. Furthermore as most of the toilet structures are pit latrines and therefore temporary constructions, owners are easily able to construct them without approval from the planning authorities. Also important to note is that in the context of Kisumu slums, it was observed that households may share pit-latrines therefore this is not a major determinant in selection of rental units.

$$\chi^2(1, N = 4122) = 0.00, p = .95 \quad \textbf{(6-1)}$$

Looking at the actual count and expected counts for renters without access to toilets we see that these values are same, therefore, we conclude that the percentage of households with access to toilets is not associated to the type of house ownership.

Table 6-3: Crosstabs-house ownership *access to toilet; a), case processing summary, b) cross tabulation and c) chi-square statistics

a) Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Ownership of house * no toilet	4122	98.9%	44	1.1%	4166	100.0%

b) Ownership of house * no toilet Cross tabulation

			no toilet		Total
			With toilet	No toilet	
Ownership of house	Yes	Count	820	9	829
		Expected Count	820.2	8.8	829.0
	No	Count	3258	35	3293
		Expected Count	3257.8	35.2	3293.0
Total		Count	4078	44	4122
		Expected Count	4078.0	44.0	4122.0

[10] Halved in two to support the one-tailed test.

c) Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.003[a]	1	.954
Likelihood Ratio	.003	1	.955
N of Valid Cases	4122		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.85.

6.1.4.2. Tenure and access to water

Indicator S2 pertains to access to water and in this context we assume that house owners tend to have more water connections than renters. Most importantly here we note that the actual counts indicate higher numbers of households without access to water than the expected count.

$$\chi^2(1, N = 4112) = 19.00, p = .00 \quad \text{(6-2)}$$

We can therefore safely reject the null hypothesis and conclude that house owners have better access to water than renters as the value $(X^2) = 19 > (X^2)^* = 3.84$.

Table 6-4: Crosstabs-house ownership *access to water; a), case processing summary, b) cross tabulation and c) chi-square statistics

a) Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Ownership of house * no water	4112	98.7%	54	1.3%	4166	100.0%

b) Ownership of house * no water Cross tabulation

			no water		Total
			With water	No water	
Ownership of house	Yes	Count	152	676	828
		Expected Count	100.3	727.7	828.0
	No	Count	346	2938	3284
		Expected Count	397.7	2886.3	3284.0
Total		Count	498	3614	4112
		Expected Count	498.0	3614.0	4112.0

c) Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.006[a]	1	.000
Likelihood Ratio	34.726	1	.000
N of Valid Cases	4112		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 100.28.

6.1.4.3. Tenure and access to electricity

Indicator 3-access to electricity is a unique indicator in the context of Kisumu slums in the sense that despite alternative sources of energy used in Kisumu slums, lack of electricity is still considered a measure of deprivation.

However marginal, in this instance, similar to 'access to water' we see that there is an increased number of households under renters without electricity than expected and vice versa. Nevertheless p value is greater than α (0.05); therefore, we cannot reject the null hypothesis. We conclude that there is no association between house ownership and access to electricity:

$$\chi^2(1, N = 4114) = 0.01, p = .87 \quad \text{(6-3)}$$

Table 6-5: Crosstabs-house ownership * access to electricity; a), case processing summary, b) cross tabulation and c) chi-square statistics

a) Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Ownership of house * no electricity	4114	98.8%	52	1.2%	4166	100.0%

b) Ownership of house * no electricity Cross tabulation

			no electricity		
			With electricity	No electricity	Total
Ownership of house	Yes	Count	458	369	827
		Expected Count	455.9	371.1	827.0
	No	Count	1810	1477	3287
		Expected Count	1812.1	1474.9	3287.0
Total		Count	2268	1846	4114
		Expected Count	2268.0	1846.0	4114.0

c) Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.027[a]	1	.870
Likelihood Ratio	.027	1	.870
N of Valid Cases	4114		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 371.08.

6.1.4.4. Tenure and house durability

Quality of housing is one of the important measures of a slum; indicator 4 examines the percentage of households whose housing units are constructed from non-durable material (temporary, semi-permanent

and permanent housing). The premise here is that rental units may not be of permanent quality, especially since construction of temporary housing is done without authorization and constitutes the greatest proportion of rental units. We also consider the probability that renters will be attracted to housing units by the cost of rental much more than the durability.

In checking the relationship between house ownership and house durability we are able to draw the conclusion that there is an association between the two variables as $p<0.05$; hence house owners have better housing quality than renters.

$$\chi^2(1, N = 4126) = 7.03, p = .00 \quad \text{(6-4)}$$

Table 6-6: Crosstabs-house ownership * house durability; a), case processing summary, b) cross tabulation and c) chi-square statistics

a) Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Ownership of house * house durability	4126	99.0%	40	1.0%	4166	100.0%

b) Ownership of house * house durability Crosstabulation

			house durability		
			Permanent	Temporary/Semi-permanent	Total
Ownership of house	Yes	Count	439	392	831
		Expected Count	389.1	441.9	831.0
	No	Count	1493	1802	3295
		Expected Count	1542.9	1752.1	3295.0
Total		Count	1932	2194	4126
		Expected Count	1932.0	2194.0	4126.0

c) Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.060[a]	1	.000
Likelihood Ratio	15.032	1	.000
N of Valid Cases	4126		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 389.12.

6.1.4.5. Tenure and overcrowding

Lastly we look at indicator 5 which overcrowding. The theory here is that house owners will not have problems of overcrowding as they have the alternative to extend the existing housing unit, unlike renters who are restricted to cost and availability of housing.

The difference in percentages of households with problems of overcrowding is subject to ownership status with indication of self owned households having less occurrence of overcrowding than rental units.

$$\chi^2(1, N = 4021) = 6.53, p = .01 \quad \text{(6-5)}$$

Table 6-7: Crosstabs-house ownership * overcrowding; a), case processing summary, b) cross tabulation and c) chi-square statistics

a) Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Ownership of house * overcrowding	4021	96.5%	145	3.5%	4166	100.0%

b) Ownership of house * overcrowding Cross tabulation

			overcrowding		
			Not overcrowded	Overcrowded	Total
Ownership of house	Yes	Count	485	329	814
		Expected Count	452.6	361.4	814.0
	No	Count	1751	1456	3207
		Expected Count	1783.4	1423.6	3207.0
Total		Count	2236	1785	4021
		Expected Count	2236.0	1785.0	4021.0

c) Chi-square tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.530[a]	1	.011
Likelihood Ratio	6.566	1	.010
N of Valid Cases	4021		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 361.35.

In conclusion, therefore, we can summarize that access to water; house durability and overcrowding are the three indicators that share an association to house ownership. As the Pearson's chi-square test applies the 2x2 cross tabulation, we cannot infer causality but can only highlight associations and infer directionality of these associations.

6.2. Policy and its implications

This section focuses on policies that have influenced slum growth, pattern and deprivation in Kisumu slums. The main focus of this review will be on policies and programmes that have impacted on then selected locational factors-Tenure, Proximity to a major water source and major roads.

6.2.1. Land policy, land tenure and land use management

Kisumu has been seen to gradually expand over the past century, with gradual expansion into the rural hinterlands (5.3). This expansion strategically targeted the extension of development opportunities to the rural populace and provision of land for future growth of the city. However, this has resulted in the influx of economic migrants to the urban periphery and increased the demand for housing[11].

The National Land Policy (Government of Kenya, 2007) recognizes three categories of land-Public land, Community land and Private land (Government of Kenya, 2007). Most problematic of these is the private land which includes freehold and leasehold tenure. While conferring rights to the holder of the land, ideally this land is still under the regulation of the Government. The Government's strategy on development has embraced the national and regional planning with special emphasis on rural, urban and peri-urban land use planning (idem).

Kisumu's peri-urban area which over the years has turned into the slum belt falls under the category of private land. With over 80% of the land under private ownership, of which 52% is under freehold tenure, the physical planning department faces continuous challenges in administering the building development despite the existence of zoning guidelines[12] (Government of Kenya, 2010).

Table 6-8: Land tenure categories

Source: Physical Planning Department (Government of Kenya, 2010)

Type	Area (km2)	% of Municipality
Freehold	217.5	52.2
Government land(Water)	157	37.6
Leasehold	32.5	7.8
Trust land	10	2.4
TOTAL	**417**	**100**

Ownership of land in this instance does constitute a major problem as most of the land is privately owned. In place of squatting we see land owners converting their land into rental units. We see that the greatest proportion of acquisition of land coincides with the expansion of the district boundaries with a minimal role played by the Government in the acquisition process (Figure 6-3). The impact of this is seen in the number of new developments ongoing. The household survey indicated percentages of 89.9 and 85.2 of respondents with new developments for Manyatta 'A' and Nyalenda 'A' respectively upon acquisition of land. Respondents from all categories unanimously indicated that temporary and semi permanent construction is not strictly subjected to authorisation permits. In this aspect the household survey indicated 74% and 93% of developments falling within this category and therefore lacking in legality of status (Figure 5-3). Expansion into the rural hinterland coupled with failure to execute the zoning guidelines as a regulatory tool for the control of illegal development have played an influential role in the slum growth and pattern of Manyatta 'A' and Nyalenda 'A'.

[11] Population of Kisumu grown from 322,734 in 1999 to over 620, 000 in 2010 (Kisumu Concept Plan draft).

[12] Zoning guidelines for Kisumu Town in annex.

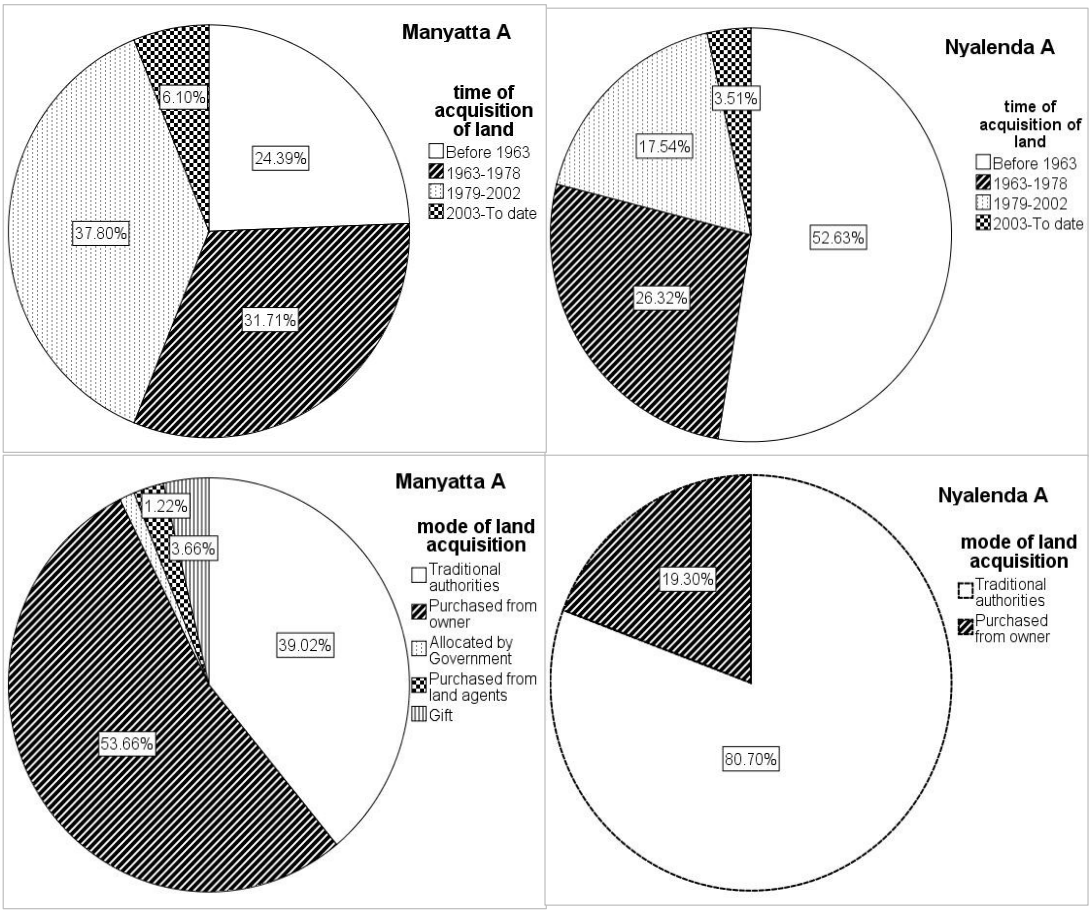


Figure 6-3: Mode and time of land acquisition in Manyatta A and Nyalenda A as drawn from household survey.

6.3. Summary

This chapter has explored the socio-economic data from Pamoja Trust enumeration of 2005/2010 and the researchers household survey to develop the slum index and assess inter and intra variation in the level of deprivation. The results from the deprivation measure have been related to the locational factor tenure to establish association. Access to water, housing quality and overcrowding have shown a relationship to the type of tenure of occupancy: self-owned and rented. Policy review has been limited to land policy, land tenure and land use management to assess the influence of policy on the locational factor tenure.

7. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarises the outcomes of this research, highlights the limitations faced in its execution and recommends potential for future research. This chapter is formulated along the three objectives from section 1.3.2.

7.1. Conclusions

Variation in urban settings and slums specifically has been widely acknowledged over the world. This research exploited the role of locational factors as an explanation for this variation. The impact of policy on these locational factors was also touched upon.

7.1.1. Objective 1: Pattern of the Kisumu slum belt

Image analysis was used to identify the pattern of the Kisumu slums and specifically the case study areas of Manyatta 'A' and Nyalenda 'A'. The combination of visual interpretation and image classification and quantification enabled achievement of this objective. The extent of Kisumu's slums is a belt along the eastern fringe of the initial CBD. This belt has evolved into slum sub locations defined by arbitrary administrative boundaries, which have over time been adopted definitively.

Image classification proved problematic with misclassification of bare land as built up area, nevertheless, accuracy levels of 82% and 86% for Manyatta 'A' and Nyalenda 'A' respectively were considered sufficient. Looking into the sub locations of Manyatta 'A' and Nyalenda 'A' there are similarities and disparities in the distribution of built-up area. The spatial metrics computed in FRAGSTATS provided measures to discern that development in Nyalenda 'A' is more clumped than that found in Manyatta 'A' (see Sec 5.2). The contagion index of 16% and 41% indicate more disaggregation of patches for Manyatta 'A' than Nyalenda 'A' respectively. The Patch density and Edge density values function as expressions of spatial heterogeneity and indicate dispersed patch distribution in Manyatta 'A' (Table 5-1).

With the support of ground validation housing typologies detected from roof shapes were developed: family, rental and mixed use housing. Shape was the main element used in the identification of the housing typologies from the satellite image, however, other recognition elements such as pattern, shadow, associated features, and size can further improve accuracy of the identification process. Whereas both Manyatta 'A' and Nyalenda 'A' show similarity in that they both contain the three housing typologies, Manyatta 'A' is seen to have a higher percentage of permanent housing (20%) which is inferred to be mixed use housing typologies (Figure 5-3). This has shown indication of veering away from the initial land use model of "green garden concept" as the increase of rental units has gradually eaten away available open space initially present in the rural setting. A shift from expansion of the slum area to densification and intensification within the existing slum sub-locations of Manyatta 'A' and Nyalenda 'A' is observed. This has been accredited to the impact of tenure which is not limited to the ownership of land but encompasses legality, occupancy and type of housing unit. This variation in the preceding paragraphs has also been attributed to road infrastructure pattern where proximity to good quality roads has attracted more and better quality development.

7.1.2. Objective 2-Locational factors and the slum index

Various locational factors are identified in this research however a selected few are discussed in the context of this study: tenure, proximity to a major water source, and roads (Figure 3-4). These were selected on the basis of predominance of private ownership of land in the slums, difference in road infrastructure pattern between the two case study areas and proportion of Kisumu area base covered by a water source. However, in the analysis of the direct impact on the slum index we focus mainly on the role of tenure. The results of the slum index from the household survey quantitatively indicate both inter and intra ward diversity (Table 6-2). The slum index for Manyatta 'A' and Nyalenda 'A' show a slight variation at 2.35 and 2.25 respectively; however greater intra variation is evident with the slum index ranging from 1.69-2.79. Overall most households are seen to fall in the category of Slum index level 2 in that they have two deprivations: lack of access to water and poor housing quality. Identified during this process is the spatial manifestation of neighbourhoods along the scope of deprivation that are not limited to administrative boundaries. This can have great implication in the process of policy review as identification and prioritisation of deprived areas for intervention can be restructured along these neighbourhoods rather than administrative boundaries. This can be a positive approach to localised programmes such as LASDAP.

Analysis into the association between tenure as a locational factor and the individual indicators that constitute the slum index confirmed a relationship with the indicators. Overall indication was that renters are worse off in terms of lack of access to water, poor housing quality and overcrowding, but not in the case of access to sanitation and electricity where no association was identified.

7.1.3. Objective 3-Policy, locational factors and deprivation

The review of policy implication has been limited to the locational factor tenure and has been structured around developing inferences from the descriptive statistics and results from Chapters 5 and 6. The dominance of private land ownership has been identified as a crucial element of the spatial growth and pattern of Kisumu slums. In the context of policy, expansion into the rural hinterland without supporting regulatory frameworks to monitor the rural-urban transition is considered a major catalyst to the slum growth and pattern of Manyatta 'A' and Nyalenda 'A'. Failure in the enforcement of the exiting zoning guidelines further accelerates the developments along the fringe as densities increase with the gradual transformation of housing typologies from family housing to rental housing.

7.2. Recommendations

Recommendations are drawn from the conclusions above and are proposed along two fronts; suggestions for applicability of this research and possibilities of future research.

7.2.1. Applicability of this research

Currently allocation of resources for upgrading projects and programmes is based on administrative boundaries. Identification of deprived neighbourhoods could better inform localised initiatives such as LASDAP and Urban Matters Program on priority areas for intervention. Furthermore, widening the scale of the study to include the entire slum belt could develop heterogeneous neighbourhoods that would facilitate strategic intervention in order of level and type of deprivation. Overall an insight into inter and intra variation could guide reallocation of resources.

Focus was placed on tenure as a locational factor, however inclusion of other factors and possible combination/clustering of locational factors may yield a wider scope of analysis and could improve results on variation (Agnihotri, 1994; Pereira, 2011). This could inform policy makers on locational factors that could be exploited to contribute to improvement or mitigation of slum conditions.

Development of an extensive data base to support similar research or assessment could benefit the municipality in terms of monitoring and evaluation of their projects. Ultimately it could provide guidance for possible review of policy/regulatory frameworks for the monitoring of future changes in Manyatta 'A' and Nyalenda 'A' and Kisumu slums as a whole.

Lastly, collaboration of initiatives is ongoing through the Urban Matters project which consolidates all key partners in slum upgrading. Approaches such as localisation of programs (LASDAP) and public participatory programs could benefit from the definition of deprived neighbourhoods as the community can actively participate in defining their priorities for example the Water Task Force of Manyatta 'A' (Figure 4-1). This will facilitate with improving localisation of interventions, inter organisational collaboration, prioritisation of urban challenges and public participation.

7.2.2. Limitations and Possibilities for future research

Research is a process of investigating phenomenon with the ultimate goal of contributing to a field of knowledge accessible to all for the benefits of overcoming challenges related to these occurrences. Before we can embark on highlighting the possibilities for future research we highlight the limitations faced during this research.

7.2.2.1. Limitations of the study

First and foremost the study was limited by the sample size (n=150); as identified in section 4.2.5 a much larger sample size of 1,939 was estimated as suitable to represent the study population. This sample size was limited by the cost and duration required to execute a large sample size.

The household survey was supposed to be supplementary to the Pamoja Trust enumeration data set, however, difference in coding and mapping systems resulted in the continued absence of a complete spatial link to the main socio-economic data set. This limited the spatial analysis of the data to aggregated levels of sub village and unit level (Table 6-2 and Figure 6-1).

The initial scope of the study integrated the component of time series in the context of urban growth analysis; however, challenges in image analysis limited the study to the year 2009 and focused only on spatial pattern. Extraction of urban growth over the period of 2003-2009 was not achieved.

7.2.2.2. Possibilities for future research

In conclusion therefore the following avenues for future research are recommended:

Expansion of scope in terms of including more locational factors and possible clustering of factors with similar implications on slum growth, pattern and deprivation could develop even wider variation.

Consideration of a wider spatial scale in terms of a larger coverage area such as the whole of Kisumu slum belt or expanding comparison to different towns altogether may also impact the heterogeneity levels and provide interesting results to broaden the study of inter and intra variation. In this case the assumption is that different geographic settings will also manifest different locational factors for example if comparison was to be drawn between slums of Kiumu and Nairobi. Both are major cities of Kenya, but face different urbanisation processes.

Re-examination of Kisumu slum after a period of time to evaluate the policy implication from the ongoing projects. Furthermore, this would provide an opportunity to revisit the aspect of slum growth analysis.

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APPENDIX

Appendix 1 : Questionnaires

A. **Key informant interview** (Professionals and Decision Makers-Government, NGO's, CBO's, Academia)-General information.

Dear respondent,

We are students from the University of Twente-Faculty of Geo-Information Science and Earth Observation, in the Netherlands. Currently we are undertaking an important and informative research on sustainable urban regional dynamics and kindly request your assistance in obtaining relevant information to support this study.

Your invaluable response will contribute to elaborating the role of locational and policy factors in the growth of slums and deprivation in Kisumu city. We greatly appreciate your assistance and recognize the important role that your individual/professional response will play in the advancement of this field.

Kindly note that any information you provide will be treated as confidential and the findings will be reported in the aggregate only, so that information provided about you/ your organization cannot be ascertained or deduced by the readers of the report.

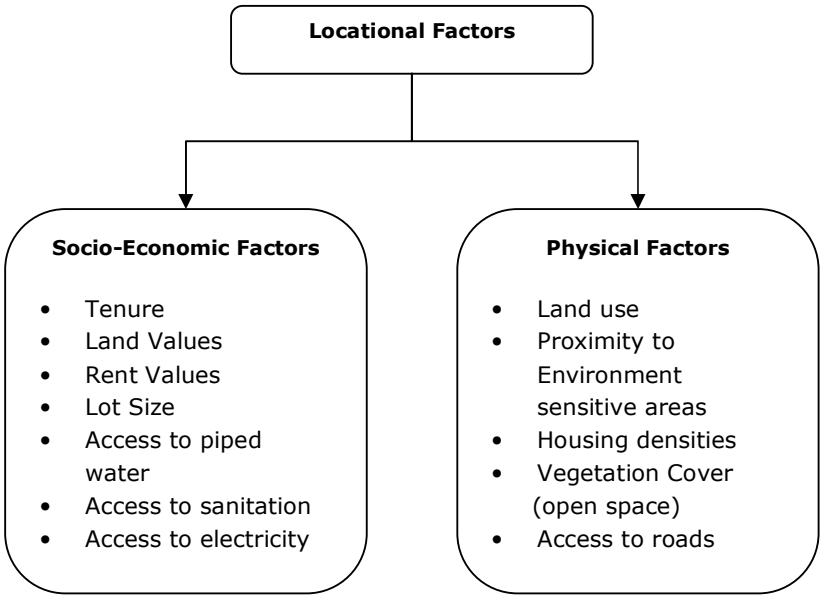
Thank you very much for according us your precious time.

1) Trend and dynamics of slum growth in Kisumu town.

   i. What land use model (master plan) does Kisumu town emulate?
   ii. How has the growth of the slum belt deviated from this model?
   iii. What characteristics have played a role in defining the slum sub locations?

2) Determinant growth factors (locational factors).

   i. What locational factors have played a dominant role in the growth of the slum?



ii. What other key factors have contributed to the slum growth in Kisumu?

3) Policy intervention.

i. What strategies have been implemented in the improvement of conditions in Kisumu slum?
ii. Who are the stakeholders involved and what roles do they play?
iii. What strategies are seen to directly impact on the determinant locational factors elaborated above?
iv. What challenges/obstacles do you face in implementing such strategies?
v. What would your recommendations be to overcome these challenges/ obstacles?

4) Additional/Optional In-depth informant interview: (Professionals and Decision Makers-Government, NGO's, CBO's, Academia)-Specific to role played.

i. What specific role do you/your organization play in the selected settlements-Obunga and Manyatta?
ii. What is the goal of you/your organizations strategies in addressing the conditions in Obunga and Manyatta?
iii. What impact have these strategies had in Obunga and Manyatta?

B. Focus group discussion (Village leaders)-Specific to sub location-Obunga/Manyatta.

Dear respondent,

We are students from the University of Twente-Faculty of Geo-Information Science and Earth Observation, in the Netherlands. Currently we are undertaking an important and informative research on sustainable urban regional dynamics and kindly request your assistance in obtaining relevant information to support this study.

Your invaluable response will contribute to elaborating the role of locational and policy factors in the growth of slums and deprivation in Kisumu city. We greatly appreciate your assistance and recognize the important role that your individual/professional response will play in the advancement of this field.

Kindly note that any information you provide will be treated as confidential and the findings will be reported in the aggregate only, so that information provided about you/ your organization cannot be ascertained or deduced by the readers of the report.

Thank you very much for according us your precious time.

i. When and how was this settlement established?
ii. What characteristics have played a role in defining the slum sub locations?
iii. Have the following locational factors contributed to the establishment and growth of this settlement? (Limited to the priorities defined during the Key informant interviews)
iv. What other key factors have contributed to the growth of your settlement?
v. What schemes/projects have been implemented in your settlement?
vi. What impact have these schemes/projects had on the conditions in your settlement?
vii. What role, if any, do you play in facilitating the implementation of these schemes/projects?
viii. Are you satisfied with the impact of these schemes/projects?
ix. What challenges have these schemes/projects faced during implementation?
x. What recommendations do you have for the improvement of these schemes/projects?

C. Property owner questionnaire (Sampled households)

Dear respondent,

We are students from the University of Twente-Faculty of Geo-Information Science and Earth Observation, in the Netherlands. Currently we are undertaking an important and informative research on sustainable urban regional dynamics and kindly request your assistance in obtaining relevant information to support this study.

Your invaluable response will contribute to elaborating the role of locational and policy factors in the growth of slums and deprivation in Kisumu city. We greatly appreciate your assistance and recognize the important role that your individual/professional response will play in the advancement of this field.

Kindly note that any information you provide will be treated as confidential and the findings will be reported in the aggregate only, so that information provided about you/ your organization cannot be ascertained or deduced by the readers of the report.

Thank you very much for according us your precious time.

Interviewer's Name	**Date**	**Case Study Area**	**Ref. No.**

Section A: Land access (Tick the appropriate box)

1) Respondent's name ……..
2) Gender ☐ Male ☐ Female
3) Land use (2010)?
   ☐ Residential ☐ Commercial ☐ Residential/ Commercial
   ☐ Religious ☐ Hospital/ Clinic ☐ Educational
   ☐ Light industrial (Jua kali) ☐ Other (specify)…….
4) Has this been the predominant land use since 2003?
   ☐ Yes ☐ No

If No, please specify previous land use and reason for change……
……...

5) Mode of land acquisition/access?

☐ Traditional authorities (clan heads; village heads; family heads; lineage heads)

☐ Government agencies (e.g. chiefs)

☐ Non indigenous land sub-dividers/ speculators

☐ Other (specify)……..

6) What is the size of the lot/land now? ……m2.

7) Has this been the size since 2003?

☐ Yes ☐ No

If No, please specify previous lot/land size and reason for change……
…….....

8) Initial cost of purchase of land (Kshs)? ……. ☐ Not applicable

(To be compared with current land values-to be obtained from authorities)

9) In which year was this land acquired?

☐ Before 1963 ☐ 1963 – 1978 ☐ 1979 – 2002 ☐ 2003 – To date

10) What was the development status of this plot at the time of acquisition? (land improvement)

☐ Vacant ☐ Half built ☐ Built

11) What infrastructure/services existed on this land at the time of acquisition?

☐ Piped water ☐ Electricity ☐ Septic tank

☐ Graded road ☐ None ☐ Other (specify)……

12) Have there been any changes in infrastructure/services available since then?

☐ Yes ☐ No

If Yes, please specify the infrastructure/service availed and when…….
…….....

13) What documentary proof did you have to show that the status of property ownership?

☐ Title deed ☐ land sale agreement ☐ No document

☐ Other document (specify) ……

14) Have any schemes/projects been implemented in your settlement during the period of 2003-2010?

☐ Yes ☐ No

If Yes, please specify which and when…….....

15) Has/Have the above mentioned scheme/s changed your conditions in the settlement?

☐ Yes ☐ No

If Yes, please specify how……..

Questionnaire for Household Survey, September - October 21010

This interview is part of fieldwork survey to support an academic reasearch on Measuring Deprivation in Manyatta Settlement, Kisumu City. The Research is part of fulfillment of the requirement for the Degree of Master of Science in Geo Information Science and Earth Observation, Spetialisation in Urban Planning and Management at the University of Twente, Netherland.
The answers given to the questionnaire will be kept confidential and used only for reasearch objectives.

Note: A respondent should either be a head of house, wife or any household member who knows a household status

Duration: Years living on the settlement:

Date: / / 2010 House / Enumeration number

Respondent Gender | Male ☐ Female ☐

Posisition in a family | Head of family ☐ Other, specify _____

	Indicators	Questions	1	2	3	4	5
1	Type of Sanitation facilities	What type of toilet do you use?	no toilet		pit latrine		flush toilet
2	Bathing Facility	What type ofBathing facility do you use?	public shower/bath	shower shared with neighbours	basin in the house	combined toilet	private bathroom
3	Safe Water	What is your primary source of water?	unprotected well	protected well	street vendors	piped water in the plot	piped water inside the house
4	Kitchen	Do you have kitchen within the housing unit ?	no				Yes
5	Electricity	Is your household connected with electricity?	no electricity		parafin, coal		with electricity
6	Energy for cooking	What is your main source of energy for cooking?	firewood	dung, makwangla		botled gas	electricity
7	Overcrowding	Household with fewer than three people per habitable room	more than 3 persons per room				3 or less perssons per room
8	Housing Location	Is the Household located in hazardous location?	very poor location		good location		very good location
9	Ventilation	What material have been used to make the window?	none/no window		wooden shooters		glass window
10	Durable Structure	housing characteristics/structure	shack	traditional stick house/temporary	semi permanent structure	improved house permanente structure	decent house/ permanent structure
11	Unemployment	How many adults in the household and how many are employed?	0-19%	20-39%	40-59%	60-79%	all
12	literacy	What is the household literacy?	< 6		6 -12		12+
13	House ownership	Do you own the house?	no				yes
14	Income	What is the household income?	none	less than 5000 Ksh	5001 - 10000 Ksh	1001 - 15000 Ksh	+15000 Ksh
15	Acces to water	What is the distance to the nearest water source?	0-50m	51-100m	102-150m	151-200m	+ 200m
16	Safety within the house		very unsafe	unsafe	neither	safe	very safe
17	Perceived well-being	Do you feel safe in the neighbouhood?	very unsafe	unsafe	neither	safe	very safe
18		Are you satisfied with the environment in your area?	very unsatisfied	unsatisfied	neither	satisfied	very satisfied
19		Which Socio-economic group do you belong to	very poor	poor	normal/moderate	confortable	wealthy

What do you think that could improve the neighbouurhood

_____

_____

_____

Appendix 2: Classification Accuracy Assessment Reports

CLASSIFICATION ACCURACY ASSESSMENT REPORT

Image File : f:/module 15-thesis proposal/new image analysis/2009/manyatta_ge2009sup.img
User Name : uwanziga22455
Date : Wed Feb 02 18:36:45 2011

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
Bare Land	19	23	18	94.74%	78.26%
Vegetation	11	15	11	100.00%	73.33%
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
Built up	20	12	12	60.00%	100.00%
Totals	50	50	41		

Overall Classification Accuracy = 82.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.7286

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
Bare Land	0.6494
Vegetation	0.6581
	0.0000
	0.0000
	0.0000
Built up	1.0000

----- End of Kappa Statistics -----

CLASSIFICATION ACCURACY ASSESSMENT REPORT

Image File : f:/module 15-thesis proposal/new image analysis/2009/nyalenda_ge2009sup.img
User Name : uwanziga22455
Date : Wed Feb 02 19:31:40 2011

ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
Unclassified	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
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	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
Bare Land	23	23	20	86.96%	86.96%
Vegetation	14	18	14	100.00%	77.78%
	0	0	0	---	---
	0	0	0	---	---
	0	0	0	---	---
Built up	13	9	9	69.23%	100.00%
Totals	50	50	43		

Overall Classification Accuracy = 86.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.7815

Conditional Kappa for each Category.

Class Name	Kappa
Unclassified	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
	0.0000
Bare Land	0.7585
Vegetation	0.6914
	0.0000
	0.0000
	0.0000
Built up	1.0000

----- End of Kappa Statistics -----

Appendix 3: Zoning guidlines

ANNEX 2 **ZONING POLICY AND BUILDING STANDARDS FOR KISUMU CITY**

Area found	*Land use*	*Density*	*Minimum Plot size*	*Plot ratio /building type*	*Plot coverage*	*Plot frontage*	*Building lines*	*Minimum plot subdivision size*	*Street width*
Milimani Riat Hills	Residential reserved	Low	0.2 Ha minimum and above	Bungalows	50%	10 Metres minimum	6 M Front 3 M Side 4.5 Rear	40 by 50m minimum	9 Meters
		Medium	0.1 Ha	Bungalows	60%	6 Meters	6 M Front 3 M Side 4.5 Rear	25m by 40m	9 Meters
Nyalenda, Manyatta, Migosi, Obunga, Lolwe, Mamboleo, Kibos, Kasule, Otonglo, Nyamasaria, Kogony	Residential Areas	Low	0.1 Ha	Multi-family dwelling units 1:4	50%	6 Meters	6 M Front 3 M Side 4.5 Rear	25m by 40m	9 Meters
		Medium	0.05Ha	Maisonettes 1:2 Maissonettes 1:4	65%	6 Meters	3 M Front 1.5 M Side 4.5 M Rear	20m by 25m	9 Meters
		High	0.03Ha	Maisonettes 1:3	75%	5 Meters	2.5 M Front 1.5 M Side 3 M Rear	15m by 20m	12 Meters
Kibos, Obote road Otonglo Kogony	Industrial	Light	Minimum 0.1 Ha	1:3		25-31 M			15+meters
		Medium	Minimum 2 Ha	1:3					
		Heavy	Minimum 10 Ha	1:3					
Found near residential areas.	Educational	Nursery	0.15-0.25 Ha for 3,500 pp	1:4					
		Primary	3.9 Ha	1:4					
		Secondary/Technical schools	4.5 Ha	1:4					
		Colleges		1:5					
		University		1:6					
Town center, Milimani Shopping centre Kondele Migosi Mamboleo Otonglo Nyamasaria	Commercial	Town Centre	0.05 Ha	Minimum 1:6	100%	3 Meters	0 M Front 0 M Side 0 M Rear	20m by 25m	18 Meters
		Local Centre	0.05 Ha	1:2					
		Intermediate centers	0.05 Ha	1:3					
		Major Centers	0.05 Ha	1:4 minimum					
		Corner shops	0.08 Ha						
	Public Utility								

Standards for Special Planning Areas

- The lake front is considered a special planning area and as such it will have special planning standards. It reserve 150m off the lake to hotels and beach resorts.