ASSESSMENT OF COMMUNITY PERCEPTION, POLICIES AND LAND USE FACTORS IN RELATION TO CLIMATE CHANGE PROCESSES IN NAIROBI CITY

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Assessment of Community Perception, Policies and Land use factors in relation to Climate Change Processes in Nairobi city

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DECLARATION

This Thesis is my original work and has not been presented for the award of degree in any other University.

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DEDICATION

This thesis is dedicated to my dad and mum for their unwavering support in my studies. To my siblings for always encouraging me throughout my academic journey. Above all, I do dedicate it to Almighty God for all the provision and guidance.

"…….Your eyes foresaw my actions; in your books, all are written down; my days were shaped before one came to be …" (Psalm 139: 16, NAB).

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LIST OF ABBREVIATIONS AND ACRONYMS

ADS	Agriculture Sector Development Strategy
BRT	Bus Rapid Transit
CBD	Central Business District
CIDP	County Integrated Development Plan
CO_2	Carbon Dioxide
EA	Environmental Audit
EC	European Countries
EIA	Environmental Impact Assessment
EMCA	Environmental Management Coordination Act
JKUAT	Jomo Kenyatta University of Agriculture and Technology
GHG	Greenhouse Gasses
GIS	Geographic Information Systems
GoK	Government of Kenya
IPCC	Intergovernmental Panel for Climate Change
KNBS	Kenya National Bereue of Statistics
KNPC	Kenya National Population Census
kWh/m^2	kiloWatts-hour per Square Metre.
LUCC	Land Use and Cover Change
LULCC	Land Use and Land Cover Changes
LIMS	Land Information Management System
MDGs	Millineum Development Goals
MGS	Metropolitan Growth Strategy

NAP	National Adaptation Plan
NARC	National Rainbow Coalition
NCCAP	National Climate Change Action Plan
NCCRS	National Climate Change Response Strategy
NEC	National Environment Council
NEMA	National Environmental Management Authority
NEP	National Environmental Plan
OECD	Organization for Economic Cooperation and Development
PCA	Principle Component Analysis
PP	Public Participation
RS	Remote Sensing
SRA	Strategy to Revitalize Agriculture
SDGs	Sustainable Development Goals
SPSS	Statistical Program for Social Scientists
UHI	Urban Heat Island
UN	United Nations
UNCSD	United Nations Conference for Sustainable Development
UNFCCC	United Nations Framework Convention for Climate Change
US	United States
WMO	World Meteorological Organization

ABSTRACT

As result of compounding factors related to environmental, social, economic and political pressures, it is feared that the impacts of climate change and variability may overwhelm resilience of urban systems in developing countries if response strategies are not strengthened. Urban planning policies shape the future trends and concentration of population, socio-economic activities, and infrastructure in cities. City governments and their stakeholders are essential in designing and ensuring the delivery of cost-effective climate change and variability response strategies. Just like any other city, Nairobi City has been faced with many climate-related challenges due to population growth that has resulted to pressure on existing infrastructural facilities. In this study, the perception and mitigation preferences analysis for Nairobi residents was used to anticipate their action in response to climate change to formulate informed climate change response strategies. A cross-sectional survey design was adopted where 397 households were selected through random sampling from different administrative units in the city. The study found that majority of the respondents were only aware of climate change and variability issues directly linked with daily weather patterns compared to more complex and indirect environmental problems associated with climate change in cities. This also influenced the respondent's choice of climate change and variability response strategies. Educational status of respondent's significantly influenced their responses compared to other social demographic factors. This study also attempted to demonstrate the potential impact of urban planning and building design policies to improving the resilience of Nairobi city to climate change impacts. An extensive review of existing national policies related to urban planning, environmental and building designs as well as climate change was undertaken against a protocol of desirable best international practices on climate change management in cities. Various urban planning components were addressed by different policy documents reviewed. Although, the relative coverage rate was low for different policies most of them were well detailed by policy documents which had addressed them. Although the city continues to suffer from environmental quality, unregulated land use conversion; unapproved and poorly constructed buildings, the study found that the existing policies can potentially address these issues and as a result, improve Nairobi's resilience to climate change impacts. Lastly, this study attempted to quantify the relationship between land use, agriculture, forestry and environmental protection policies on land use/cover processes in Nairobi city from 1976 to 2015 in an attempt to demonstrate the effectiveness of land use policy on management of land use/cover processes. The policy analysis was based on three analytical case studies that used integrated techniques of remote sensing, geographic information system, and field-based datasets to understand land-use/cover modification in Nairobi. The results of this study indicate that land policy change greatly influenced land use/cover changes. For instance, forests cover which had reduced by about 76% between 1976 and 2000 increased significantly from 63.63km^2 in 2000 to 93.44km^2 in 2015 as result of new forestry and environmental policies which were introduced to since 2000.

CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Scientific evidence on climate change and variability is now well documented, and the impacts are increasingly becoming strong as climate information data, and climate models become more sophisticated **(**Ruth & Gasper, 2008 & IPCC, 2007). It is predicted that climate change may potentially damage every natural and human resource on earth if management strategies are not strengthened (Garnaut, 2008). According to the IPCC (2007), scientific evidence suggests that the climate change is caused and intensified by anthropogenic greenhouse gas emission and that limiting these emissions will ultimately limit impacts of climate change (Garnaut, 2008). Mitigation efforts are seen as a major global response because they primarily aim at lowering greenhouse gases (GHG) emissions across a variety of scales (McEvoy *et al.*, 2006). Adaptation to climate change, on the contrary, is viewed as taking direct action to minimise and manage the predicted and expected adverse effects of climate change before and as they happen (Matthews, 2011). Promoting adaptation strategies in cities represent a shift away from mitigation as the primary response tool (Barker, 2007; Stern, 2006) as both tools will help in reducing the severity of future climate change impacts (IPCC, 2007).

Urban system is a continually evolving spatial product of the flow of economic, social, infrastructural and ecosystem networks and as a result, urban centers are considered as the critical driver to climate change and; while being principle emitters of greenhouse gases (GHGs), they are also vulnerable to the adverse impacts posed by climate change (Govindarajulu, 2014). Additionally, specific characteristics unique to cities such as hard surfacing, paving, high building densities, GHG emissions, and population pressure increase their vulnerability to climate change and variability. Some of these climate change and variability risks and vulnerabilities include the urban heat island (UHI), increased cases of flooding, inland storm surges as well as increase in extreme heat events (Matthews, 2011; Yiannakou & Salata, 2017).

Global and local climate change response has been dominated by international and regional negotiations. Some of the notable treaties, conventions and protocals related to climate change include; the United Nations Framework Convention for Climate Change (1992), Montreal Protocal (1987), Kyoto Protocol (1997), Vienna Convention (1988), Agenda 21 (1992), Brundland Report (1987), Paris Agreement (2015), United Nations Habitat III (2016) and the C40 (Cities Climate Leadership Group) . The most recent negotiations such as Paris Agreement has been as step forwards as it takes the Kyoto Protocol to a higher level by calling member states to increase their ability to adapt to adverse impacts of climate change. Further, member states are required to foster climate resilience and low greenhouse gas emission development in a way that does not threaten food production (UNFCCC, 2015).

Acknowledging cities as key contributors to global climate change and their vulnerability to climate ravages, more focused negotiations have been held to discuss how cities resilience can be advanced. For instance, the UN Habit III: *New Urban Agenda*, promotes development of cities that are ready to adopt and implement disaster risk reduction and management. This is seen as a major step towards reducing vulnerability, building resilience and responsiveness to natural and manmade hazards as well as fostering mitigation and adaptation to climate change (UN Habitat III, 2016). The declaration further requires States to enhance environmental sustainability in cities by promoting clean energy, sustainable use of land and resources in urban development. The objects of this declaration are to be achieved by protecting ecosystems and biodiversity by adopting healthy lifestyle in harmony with nature; promoting sustainable consumption and production patterns; building resilience; reducing disaster risks; and mitigating and adapting climate change (UN Habitat, 2016).

The objectives of the UN Habitat III are supported by the C40 Cities Climate Leadership Group (C40) which connects 94 greatest cities across the world. The C40 is focused on tackling climate change by driving action to reduce GHGs and climate risk so as to improve health, wellbeing and economic opportunities of urban population (C40 Cities,

2015). Evidently, the role of cities in controlling climate change and variability is undeniable, and there is a need for cities to develop interest and a sense of responsibility in managing climate change effects (Brondy *et al.,* 2008). City governments and their stakeholders are essential in designing and ensuring delivery of cost-effective mitigation and adaptation strategies that does not create conflict each other (Brondy *et al.,* 2008; Van Staden, 2014; Yiannakou & Salata , 2017). In addition to empowering local governments, national policies could leverage existing local experiments, strengthen policy response, enhance resource mobilization and engage local stakeholders (OECD, 2010; Owino *et al.,* 2014).

Some cities within the OECD have been in the forefront in identifying the opportunities for adaption and mitigation activities and have implemented them locally (OECD, 2010). For example, London established Climate Change Action Plan in March 2007 with the aim of reducing GHGs by 60% between 1990 and 2025 (Füssel, 2007; Kern & Alber, 2009 & OECD, 2010); The New York City via the "A Greener, Greater New York Campaign," set in April 2007 called for 30% reduction from 2005 to 2030 (Kamal-Chaoui, 2008; OECD, 2010) and Tokyo's Climate Change Strategy set up in June 2007 called for 25% reduction from 2005 to 2020 (OECD, 2010). Additionally, more than 1000 Mayors from major cities in the United States signed Climate Protection Agreement to require them to exceed Kyoto Protocol targets even though the Federal Government had not ratified the protocol (OECD, 2010).

Kenya and indeed the horn of Africa region are incredibly susceptible to unprecedented climate change and variability issues. These challenges pose a severe threat to the social-economic development of these nations. For instance, frequent droughts and floods events, in particular, have devastating effects on the environment, society and broader economy thereby threating Kenya's commitment to achieving Vision 2030 and SDGs targets (National Adaptation Plan, 2015-2030). Although Kenya's contribution to the greenhouse emissions globally could be negligible, its fast-growing population and economy coupled with urbanisation have the potential to increase future GHG emission (Government of

Kenya, 2013). The country is expected to become a predominantly urban country by 2033 due to rural-urban migration and population growth (Government of Kenya, 2013). Therefore, promoting principles of sustainable development for Nairobi city may require coherent policy and enabling institutional framework to guide decision-makers in developing spatial plans that are climate sensitive as well as regulatory bodies to ensure policy implementation and compliance. In the absence of such a policy and institutional framework, substantial obstacles will come in and prevent the identified priority actions and implementable initiatives from providing tangible climate change benefits to the residents of Nairobi (Government of Kenya, 2010).

1.2 Statement the Problem

Currently, about 50% of the global population lives in cities, and the number is expected to increase to about 70% in 2050 resulting to increased consumption levels and pressure on the natural and ecological systems in urban areas (McGranahan & Satterthwait, 2014). The process of urban planning and development has been linked with climate change and variability, not only as part of the problem but also as a solution to climate change adaptation and mitigation (Corfee-Morlot *et al*., 2009). Cities with their high spatial dynamics and growing socioeconomic inequalities are becoming a hot spot and driving force for world climate change posing a significant challenge for sustainable development schemes.

Nairobi just like any other city in the world faces threats of climate change and variability (Government of Kenya, 2010). The city's population rose from 119, 000 in 1948 to 506,286, 827,775; 1,318,369; 2,143,254 to 3,138,369 in the years 1969, 1979, 1989, 1999 and 2009 respectively (Oyugi *et al.,* 2017). Currently, the population of Nairobi city is estimated to be approximately 4.0 million people (KNBS, 2018) whereas its administrative boundary remains the same since 1963 (Mundia and Aniya, 2006). While myriads of policies guide urban planning and development in Kenya, Nairobi's development has been haphazard and disjointed (Mutingámativo, 2015). Slums and unapproved structures continue to grow (Muting'a, 2015; Mwaniki *et al*., 2015) increasing the vulnerability of

residents to climate change impacts. A study by Oyugi *et al*. (2017), indicated that most informal settlements in Nairobi are located in the urban marginal lands including floodplains, river banks, and abandoned quarries as well as near to dump sites hence predisposing the residents to climate change ravages. Over the past few years, a considerable number of people have lost their lives due to flooding and waterborne related diseases in Nairobi.

Environmental degradation has been significant in Nairobi due to land use/cover change (LUCC) (Oyugi *et al.,* 2017). GHG emission coupled with LUCC enhances the occurrence of urban heat island (UHI) which influences urban climatic parameters resulting in increased heat stress for humans, plants, and animals. Whereas adaptation and mitigation strategies are associated with the management of UHI cities, there is no research in Kenya which has examined the efficacy of the existing policy strategies in respect to climate change management in Nairobi. In addition, there is no single study which has assessed the resident's perception of climate change and their policy preferences in Nairobi, instead, most of the studies have focused on evaluating climate change perception of farmers and pastoral communities in various parts of the country (Adimo, 2016; Ndambiri *et al.,* 2013; Silvestri *et al.,* 2012).

1.3 Justification of the Study

Policy, legislative and regulatory framework for climate change response provide legitimacy, set goals and regulate conduciveness that ensures compliance to various adaptation and mitigation measures. The United Nations Conference on Sustainable Development (UNCSD) held in Rio de Janeiro, Brazil in 1992 led to the adoption of Agenda 21 which is the blueprint for environmental principles, policies and action plan required to be taken by all nations to manage climate and environmental issues. Since its adoption, mitigation strategies are considered as a better cure for climate change compared to adaptation strategies. Delayed response to climate change issues will result to higher costs in future and to manage these unavoidable consequences, it is vital to strengthen

adaptation strategies which primarily aim at benefiting local communities compared mitigation strategies whose benefits are felt at the global level (Jopp *et al.,* 2010).

Kenya remains committed to sustainable development blueprints stipulated in *inter alia,* Africa Agenda 2063, Vision 2030, Sustainable Development Goals (SDGs) and New Urban Agenda. These blueprints provide the legal basis for promoting sustainable development and thus, integrating both adaptation and mitigation strategies in urban planning and development of Nairobi will enhance the city's resilience to climate change and variability effects in future. In view of this, this study will help in understanding the perception, attitude and policy preferences for residents of Nairobi as a basis of formulating informed climate change response strategies. Further, this enhances understanding of how urban planning, environmental and building design policies can be used to improve Nairobi's adaptability and resilience to climate change and variability. Lastly, this study demonstrates how land use policy can be used to manage land use/cover process in cities as a basis for climate change management.

1.4 Research Objectives

1.4.1 Main Objective

To assess community perception, policies and land use/ land cover processes in Nairobi City to support the development of informed climate change mitigation and adaption strategies for cities.

1.4.2 Specific Objectives

1. To assess the community perception and mitigation preferences for climate change in Nairobi city.
2. To analyse the existing urban planning and building design policies in relation to climate change adaptation and mitigation in Nairobi city.
3. To evaluate the relationship between land use policy and land use/cover change between 1976 and 2015 in Nairobi city.

1.4 Research Questions

1. What are the community's perception and policy preferences on climate change adaptation and mitigation in Nairobi city?
2. Are the existing urban planning and building design policies efficient for managing climate change impacts in Nairobi city?
3. How has land use policy change affected land use/cover patterns in Nairobi between 1976 and 2015?

1.5 The scope of the study

This research was carried out in Nairobi City County, the capital city of Kenya between January 2017 and June 2018. Different research methods were used to collect and analyse data. For the community perception data, all households within the jurisdiction of Nairobi City County were considered, and different research approaches were used to selected divisions, villages, households and family members for the interviews. Existing policies in Kenya with a bearing to urban planning, land use planning, building designs, and environmental standards were considered for quality assessment in respect to climate change management in Nairobi. Three analytical case studies on LULCC were selected to form the basis for evaluating land use policy change and land use/cover processes in Nairobi between 1976 and 2015. The scope of the land use policy change was limited to land use planning, agricultural, forestry and environmental policies in the post-colonial era which had more than four years of implementation.

1.6 Study limitations

The study had several limitations. Firstly, some of the respondents were reluctant to answer the questionnaires, but they were assured that their information would be treated with the utmost confidentiality and only for the study. Secondly, there was a literature review limitation because very few empirical studies have been done on policies and climate change in Kenya. This study, therefore, borrowed heavily from other countries

which were in one way or another at a different development level with Kenya to add a scholarly thought to the limited local studies.

1.7 Conceptual Framework

Urban environment can be conceptualised as consisting of three major components namely; human, biophysical features and policy framework. The human elements of cities include artifacts and structures of individual/ or community like social networks, cultural values, institutions, and housing development. The biophysical components refer to the biotic and abiotic components of the urban landscape. The policy framework refers to the local interventions rules, regulations, visions and strategies for managing both human and biophysical components. Urban climate change policies in cities are a predominant part of the local policy component because they provide guidelines for spatial distribution of economic and social activities. Urban environment including distribution of land use, infrastructure, economic functions results from the interaction of these three essential components over a given time and space.

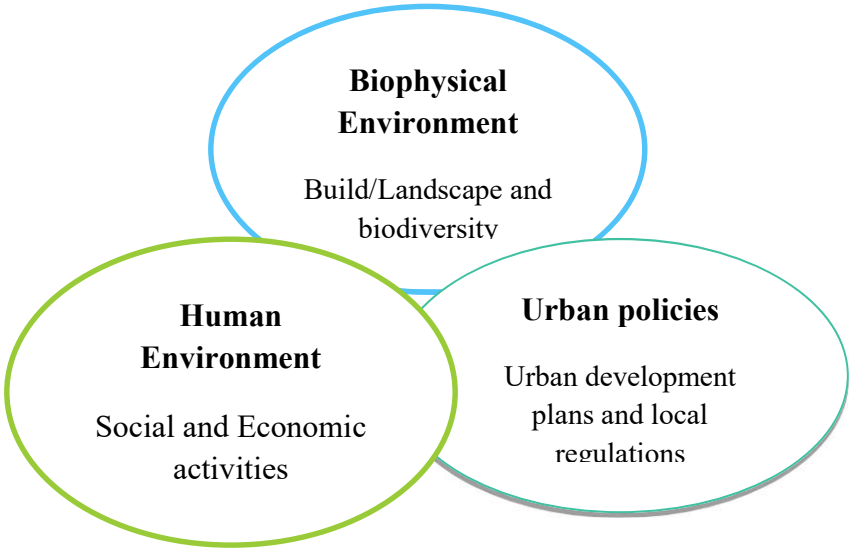

Figure 1. 1: Interaction of various components in city environment

To conceptualise the level of awareness and the perception of residents on climate change and the implications of local policies in climate change management in Nairobi City; the dependent variables for the study were the level of climate change awareness and perception of residents on local policies and their implications on climate change management. Respondent's socio-demographic characteristics were treated as the independent variables influencing the resident's level of awareness, knowledge, and perception on climate change in Nairobi. This relationship is illustrated in figure 1.2.

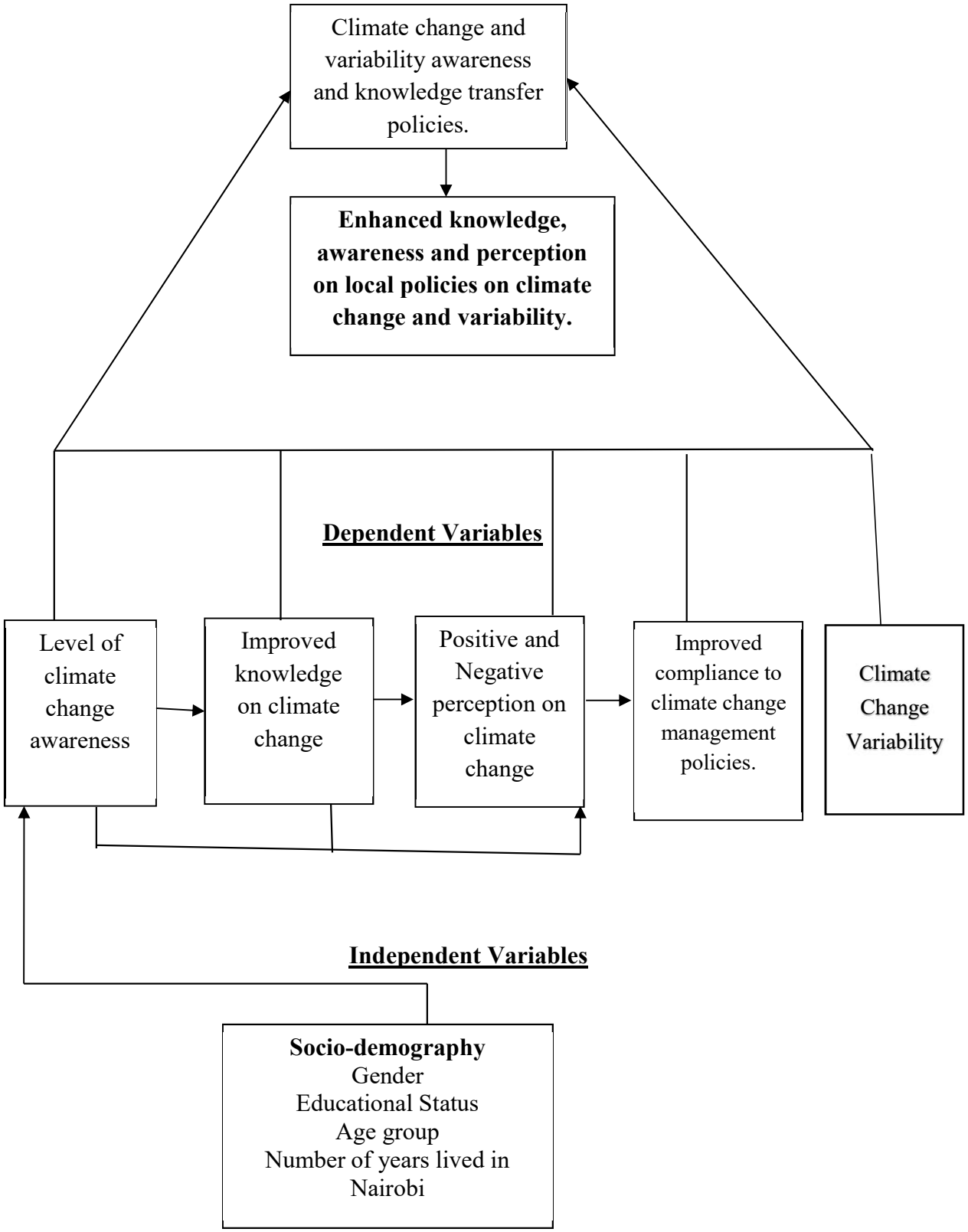

Figure 1. 2: Conceptual Framework on Public Perception on Climate Change and Variability

CHAPTER TWO

LITERATURE REVIEW

2.1 Understanding Climate Change and Variability in Cities

According to the World Meteorological Organization (WMO), the build-up of greenhouse gases in the atmosphere alters the radiative balance of the atmosphere. The net effect is to warm the Earth's surface and the lower atmosphere because greenhouse gases absorb some of the Earth ís outgoing heat radiation and reradiate it back towards the surface. Climate change in IPCC usage refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a shift in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and that is in addition to natural climate variability observed over comparable periods. On the other hand, Climate variability refers to changes in the average state and other aspects of the climate over space and time beyond that of individual weather events. Variability can be due to natural climate processes (internal variability), or natural or human-induced external changes (external variability) (IPCC, 2007). Cities face unique climate change challenges because their environment has distinctive biophysical features compared to their surrounding rural areas (Gill *et al.*, 2007).

According to Matthews (2011), these features include:

i. Sealed surface that reduces absorption of rainwater thus resulting to storm waters and increased flood risks.

ii. Asphalt, concrete, tarmac and another hard surfacing that absorb heat from the sun resulting in Urban Heat Island (UHI) effect that increases urban temperatures.

iii. Rural-urban migration resulting in population densities in cities that put pressure on available green spaces that can reduce heat, air pollution, and water runoff.

iv. High population densities that put pressure on existing infrastructure leading to reduced green spaces that could reduce heat, air pollution, and water runoff.

Additionally, climate change and UHI effects in cities (figure 2.1) are influenced by various factors such as patterns of settlement, spatial configurations, land use allocation, lifestyles and consumption behavior (Emmanuel & Fernando, 2007; Yiannakou & Salata, 2017). Altogether, these factors result in the observed inadvertent climate modification in cities thereby affecting urban communities, their lifestyle, recreation, movement and the built environment (Douglas *et al.*, 2008). Despite their vulnerability to climate change impacts, cities are considered, concomitantly, to have the highest potential to respond the changing climate through the adoption of different adaptation and mitigation policies and actions in their planning process (Klein *et al.*, 2005; Yiannakou & Salata, 2017). Understanding the fundamentals of climate change in cities forms the basis for devising and implementing different measures to counter-respond to different threats posed by climate change in cities (Kern and Alber, 2008).

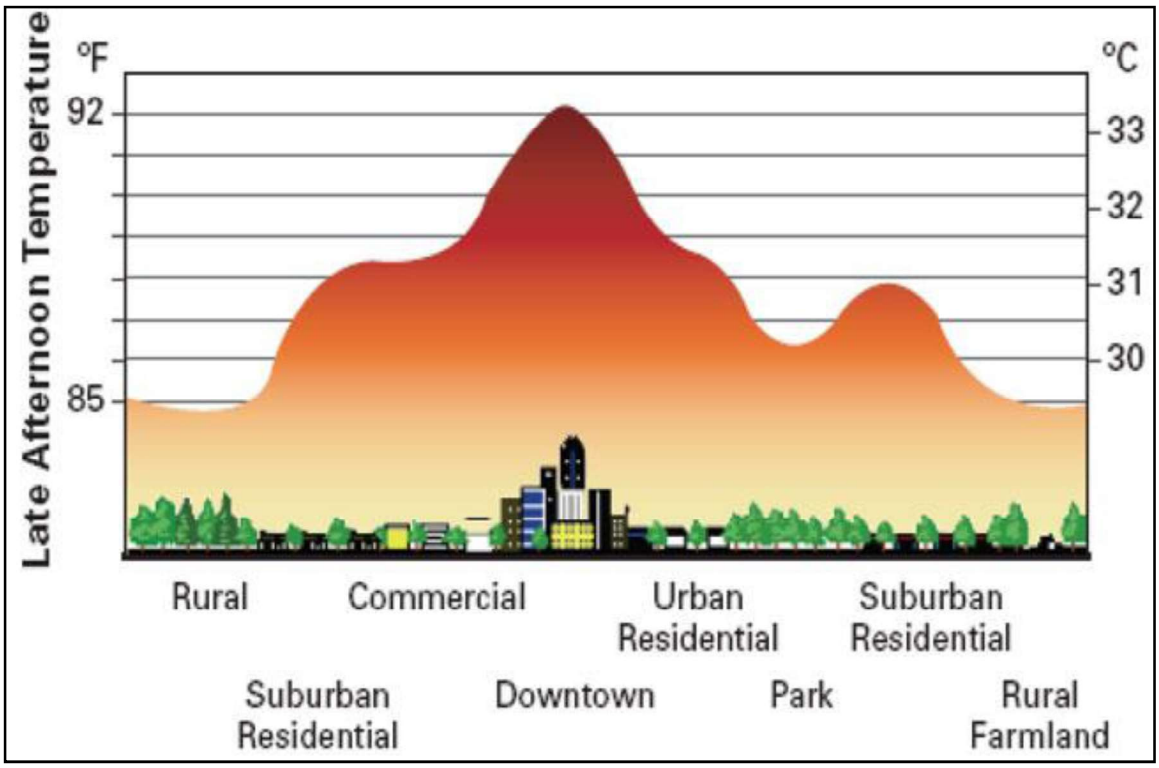

Figure 2. 1: Urban Heat Island Profile (Source: Google, 2018)

2.2 Climate Change Mitigation and Adaptation Strategies in Cities

Mitigation strategies broadly refer to anthropogenic interventions that seek to reduce greenhouse gas sources and promote greenhouse sinks (IPCC, 2007). According to Stehr and von Storch (2005) and Stern (2006), these response strategies are majorly designed to protect the climate from the anthropogenic impact. Laukkonen *et al.,* (2009) notes that such activities include renewable energy implementation aimed at enhancing energy security, infrastructural networks, and energy efficient technologies at the local level. Mitigation strategies are often viewed as a global responsibility because it is expected that if more significant stressors like industrialised countries and power generation industries, can reduce their emissions then the overall global concentrations can as well be reduced (Laukkonen *et al.*, 2009). Therefore, most researchers have generally agreed that international and national policies are expected to play a critical role in climate change mitigation (Lashof and Tirpak, 1990)

According to Bohannon (2007), there is increasing understanding of the critical role of local policies as well as individual actions to ensure proper implementation of mitigation policies. He further observes that local policies aimed at promoting sustainable and low-carbon energy development are critical in supporting carbon reductions initiatives in the power generation sectors. Similarly, individual choices to use bicycles or walk for short distances will generally reduce vehicular emissions. Therefore, mitigation policies and action plans are not limited to carbon emissions negotiations as envisaged in the Kyoto protocols, but they are also implemented at the city level as envisioned in the Cities for Climate Protection report (OECD, 2010).

While mitigation strategies are necessary to bar more changes in the natural climatic systems, scientific reports allude that some changes may be inevitable (Smith *et al.,* 2000; Smith & Lenhart, 1996). The response to natural climate change in the production, demographic, socio-economic and technological patterns cannot be readily ascertained (Frankhauser & Tol, 1996). It is, therefore, likely that individual impacts are unavoidable making it imperative to incorporate adaptation strategies along with mitigation strategies (Smith & Lenhart, 1996). Climate change adaptation strategies refer to the adjustments in the natural and human systems in response to a climatic stimulus or its effect (actual or expected), that reduces the harmful impacts or explores beneficial opportunities (IPCC, 2007).

According to Stern, (2006) international interventions are necessary to safeguard the society from the dangerous effects of climate change. Huq *et al.* (2006) noted that adaptation policies are associated with greater uncertainty compared to mitigation strategies and ordinarily unpopular with many government policies that prefer short-term solutions. Scholars lament that there's lack of attention to adaptation policies at all levels because of lack of infrastructure to handle these uncertainties and the need to allocate scarce public resources for an activity that is seen to be beneficial in future (Laukkonen *et al*., 2009; Rosenzweig *et al.*, 2011).

Adaptation strategies include enhancing the capacity of individuals, communities, organisations or the government in adapting to climate change effect and the transformation of the function into action through implementation decisions (Tompkins & Adger, 2005). Early IPCC reports had limited adaptive strategies at the local level, but now most scholars agree that these actions have to be embraced across the board and in most sectors. Smith & Lenhart, (1996) observed that these actions could occur as policy facilitated market developments, social capacity building or extension social networks. Also, the nature of the adaptive responses will depend on the level of the climate change threat on the local environment and the integral adaptive ability of the actor (Shackley & Wynne, 1996).

2.3 Synergies and Conflicts between Mitigation and Adaptation Policies

Scholarly studies on climate change suggest that there is no enough research on adaptation actions over the past years (Stehr & Storch, 2005). According to Stern, (2006) there is a need for a definitive shift towards more adaptation studies as there is increasing scientific evidence that mitigation policy and practices cannot solely protect the society from the adverse effect of climate change. Stehr & Storch (2005) adds that efforts to manage climate change adversities from the community (mitigation actions) have to be supported with efforts to protect the society from the inevitable changes in the climate (adaptation actions). Thus, it is paramount to find a synergy between mitigation and adaption actions and then utilise them to moderate climate change effects in a cost-effective manner (Tompkins & Adger, 2005).

Mitigation policies and practices are geared towards controlling the future concentration of greenhouse gases in the atmosphere and as a result moderate ensuing environmental impacts. According to IPCC (2007) reports, reducing stress on the climatic system by adopting mitigation actions can as well cut the cost of adaptation practices. The report further notes that many adaptation activities like forestation of floodplains and urban forestation can lower stormwater run-off as well as help in carbon sequestration (mitigation benefit). Mitigation policies seek to reduce the need for adaptation actions in

the future. On the other hand, cost-effective adaptation practices help to protect society from climate change effects as well as reduce the degree of required mitigation actions (Dessai & Hulme, 2013). Thus, there is a need to determine the mix that should guide public policy as well as community actions. Kane & Shogren, (2000) noted that mitigation and adaptation policies together assess the effectiveness of climate change management cost-effectively.

Achieving a balance between the cost of implementing each policy option, it is imperative to start from both directions and then balance the expenses at an optimal mix of mitigation and adaptation actions (McKibbin & Wilcoxen, 2004). Nordhaus (2008) argued that it is unwise to choose one policy option over the other because both possibilities reduce the severity of climate change effects and can jointly ensure prudent use of public resources. Nonetheless, at times, mitigation and adaptation practices can undermine the objective of each other. Any policy actions that are designed without adequately addressing the synergies and conflicts in the strategies can be counterproductive and waste public resources (Klein & Maciver, 1999). For instances, emphasis on urban forestation can lower residential densities hence more vehicle trips, that will be counterproductive to the mitigation energies.

Thus, as stated earlier, an optimal policy mix will be paramount to ensure a balance between urban greenery and residential densities (Hamin & Gurran, 2009). According to McEvoy *et al.* (2006), the primary challenges in integrating mitigation and adaptation interventions are differences in scales and time of each activity. The authors observed that mitigation practices are undertaken within the framework of global and national policy whereas, the adaptation practices are more within the regional and local context. Also, the benefits of mitigation policies are realised after a long time as those for adaptation policies are felt almost immediately after implementation. This fact underlines the importance of each intervention strategy to achieve both short and long-term goals of climate management in cities.

Similarly, to ensure the success of these strategies, it is essential to design development policies based on the local context (Klein *et al.,* 2005). It is recommended that these policies be based on local data, active public participation and inter-sectorial consultations within cities (Moss *et al.,* 2010). Another conflict that may arise between mitigation measures and community needs include demand for energy for development, construction, and manufacturing that result in employment opportunities (IPCC, 2007). In such a case, the local policy system is faced with a dilemma of sustaining the economic vitality of the local community and addressing long-term issues of climate change management (Adger, 2001; Tompkins & Adger, 2005)

Due to these conflicts, economic, social and environmental effects of climate change will vary across regions. Therefore, it is evident that particular risks facing the community may geographically influence the willingness of a community to participate in policy solution to adapt or mitigate climate change impacts. Similarly, with current climate change information where high-resolution impact models are unavailable, the perception of climate vulnerability and risk will be primarily guided by the past changes in weather pattern as well as natural hazards. Table 2.1 presents some of mitigation and adaptation actions in cities across critical sectors that may help in climate change management in cities.

Table 2. 1: Summary of multi-sectorial best practices for climate management in cities.

Policy Component	Sectorial Management Strategies
Land use and zoning	Promote mixed land use zoning and development/ or multi-sectoral approach to land use. Encourage future development through effective land management and development regulations. Promote principles of land conservation, urban agriculture, and forestry. Control rural-urban migration via proper land planning, governance and decentralisation of functions.

Policy Component	Sectorial Management Strategies
	Encourage land reclamation; EIA on development activities to manage land planning and use. promote relocation of vulnerable structure out of risk zones
Building and urban/environmental designs/ Site planning	Promote action plans to reduce UHI by use of urban forests, trees lined in streets, etc. Streamline building height/ orientation/ street width to building ratios. Encourage low-water intensive urban landscape. Approval of development plans to adhere to required environmental standards. Construction of porous car parks and walkways to reduce surface runoff. Promote green building techniques such as green rooftops, green facades in cities.
Buildings and Water management	Construct water efficient buildings Promote recycling of wastewaters Promote rainwater harvesting Promote storage/collection and recycling of wastes Energy efficient technologies
Transport/transit system	Encourage (create/implement/enhance) public transport system Increased bus stops Encourage non-motorized modes of transport (walking and cycling). Promote proper management of traffic routes and technologies. Set car off days to reduce vehicular emissions. Encourage the use of public transport. Enforce laws that reduce old inefficient cars from roads. Adopt technologies such as catalytic converters on exhaust pipes to reduce vehicular emissions.

Policy Component	Sectorial Management Strategies
Natural resource management	Set guidelines on emergency/disaster and hazard management
	Protection of sensitive areas (forests/ parks etc) from encroachment.
	Conservation of existing forests, vegetation, and riparian zones
	Creation of wildlife corridors
	Control of soil erosion to reduce discharge to rives
	Habitat protections to reduce human-animal conflicts
	Prevention of stream dumping
	Restoration of wetlands; promote sustainable use of land resources
	Encourage inventory of natural resources.
	Encourage public participation in natural resource management.
Public awareness and Disaster management	Outreach programs sensitise the public on implementation actions
	Training and technical assistance to property owners
	Disaster warning systems
	Promote public participation (PP) and awareness in climate change response.
	Provide climate change funds.
	Strengthen the enforcement and implementation of climate-related regulations.
	Strengthen early warning mechanisms such as improving climate change information and network.

2.4 The history of Nairobi urban planning

The history of Nairobi dates back to 1899 when a railway depot was constructed in a blackish Africa swamp that was occupied by pastoralist people, the Maasai and the Kikuyu people who practiced agriculture (Mwaniki *et al.,* 2015). The railway depot later expanded and urbanised until it became Kenya's capital city. The name Nairobi comes from the Maasai phrase *Enkare Nyorobi* which translates to *the place of cool water* (Vogel, 2008). Before the railway reached Nairobi in 1899, there was a need for a plan for a railway town. The choice of Nairobi as the railway depot was based on the topographical surrounding of the city. The flat terrain of Nairobi provided a suitable site for construction of workshops,

shunting areas, depots as well as commercial areas (Mwaniki *et al.*, 2015). The 1906 town plan only took into consideration the European workers and Asian traders. The city boundary covered 18km^2 and was expected to extend to 25 km^2 in 1920. This plan ignored the Asian and African workers, but its urban planning patterns showed segregation between the commercial center (CBD), the European, Asian and African residential area (Vogel, 2008). This implied that the town's functions were directly influenced by the notion of segregation by both class and race.

The 1906 master plan was replaced by the 1927 plan that was drawn by F. Walton Jameson and planned Eric Dutton who were key planners in the British Empire. The boundary of the city was extended to cover 77km^{2,} and it proposed extensive traffic regularisation to access the increased land areas (Vogel, 2008). Similarly, this plan was improved and replaced by the 1948 plan that was commonly known as colonial capital funded by both the Municipal Council of Nairobi and the Railway Authorities. The plan classified Nairobi into various zones including; city center, business, and commerce, industry, residential, suitable housing, official buildings, open space, forest reserves as well as park zones. The main spatial structure of this plan was to establish neighborhood units for the working class, segregation for surveillance and dominance. The plan also aimed at making Nairobi a more attractive industrial center (Olima, 2001; Vogel, 2008).

The 1948 plan was in place until 1973 when another plan funded jointly by Nairobi City Council, the Government of Kenya, the World Bank and the United Nations was developed. The plan aimed at decentralising services within different districts of the city to reduce the high density in the Central region. This plan also focused on improving transport routes from Mombasa, Nakuru, and Thika (Vogel, 2008). A network of roads was also proposed to provide maximum accessibility between residential, industrial and commercial areas. The housing developments were intended to take place in Dagoretti, Karen- Langata, the Eastern regions as well as areas outside the north-eastern city boundary around Ruiru (Olima, 2001).

Today, developments in Nairobi are based on a city plan that was developed in 1973 and was expected to expire in 2003. Legally, a master plan for a city is usually valid for 20-30 years which means all the structures constructed in Nairobi from 2003 are technically illegal (Vogel, 2008). From the above analysis, it is clear that there's a need to establish the basis on which these plans were based on and if contracted planners put into consideration the impacts that different biophysical features and changes in land use/cover would pose to the climate change. Secondly, there is a need to establish policies that guided urban planning of Nairobi putting much emphasis on the policies related to urban planning and building design. Lastly, as one of the sustainable development principles there need to establish the level of public involvement/ participation by assessing perception of the people of Nairobi regarding preference of climate change mitigation and the extent to which policies can be used to guide future development a more climate change resilient city.

2.5 Urban Planning Legal Framework in Kenya

Several statutes govern the planning and building sector in Kenya (Owino *et al.,* 2014). Before 1996, the principal planning legislation was the Land Planning Act of 1968 that aimed at controlling the development of urban lands. The Act provided guidelines for making town plans, even though; it did not spell out the content of the plans. Additionally, its use in rural areas was limited and hence left a gap restricting developers encroaching land available in rural areas. This act was revoked in 1996 when the Physical Planning Act was signed into law. This Act (Cap 286, 1996) provided for the formulation of National, Regional and the local physical planning guidelines and policies. Sections 16 and 24 of the Act streamlined regional and local development plans.

In its third schedule, the Act classified plans as long term, short term, and redevelopment plans. In between the short term plans are the subject areas, Action Area Plans, Advisory or Zoning Plans and Part Development plans (GoK, 1996). According to Owino *et al.* (2014), the control over land and the property development process is crucial in developing a better environment even though the effectiveness of the development control was altered

by lack of capacity to inspect and implement plans. The Physical Planning Act 2014 puts into effect Article 66 of the Constitution of Kenya and revises the Physical Planning Act, Cap 286 to align it with the Kenyan Constitution of 2010. Other statutes that have a bearing on the planning and building sector include; Environmental Management and Coordination Act (Government of Kenya, 2015). Agricultural Act Cap 318, Forest Act 2002 and 2005 as well as the Regional Development Act among others.

The Government Land Act Cap 280 relates both the planning and building sectors and also provides the administration and transactions to be carried out on Government land. This Act is also anchored by the EMCA 1999 which provides guidelines for environmentally sustainable development. The Act requires that development plans to ensure proper preparation of the Participatory National Environment Plans (NEP) which have sectorial coordination and linkages as well as environmental conservation measures. Agricultural Act Cap 318 similarly promotes agricultural practices that seek to conserve water and soil. The Act through its various provisions seeks to regulate different categories of land to enhance utilisation of agricultural land in Kenya. The Forest Act 2005 provides for the establishment, control, and regulation of forests in Kenya. This Act is anchored by the National Constitution 2010 which seeks to increase tree cover to 10% in the country. As such it encourages conservation of all types of vegetation cover which thereof contributes to the greening of urban areas (GoK, 2010).

According to the above analysis, it is worth noting that the lack of detailed land use planning policy to govern how land should be utilised creates disharmony in land utilisation in Kenya. The multiplicity of laws and regulations that govern planning and building in Kenya add more confusion to the sector (Owino *et al*., 2014). One of the ways to ensure the development of adaptive cities to the effects of climate change is providing planning for green cities that help to reduce the impacts of climate change in cities. The current statutes and policies fail to address the emerging issues of climate change despite the call made by various IPCC reports on building greener cities.

Additionally, more challenges are added by the nature of legislation that makes it hard for developers to understand the requirements, therefore, making enforcement difficult. These confusions have also provided conducive environments that have led to the rapid loss of green spaces in Kenyan towns and cities (Owino *et al.,* 2014). Promoting synergy between city actors, there is need to conduct research to identify these critical gaps, document the existing policies to detect conflicts between them and study the relationship between land use/cover processes and land use policy change to provide recommendations that will guide future urban planning and sustainable development.

2.6 Land Use/ Cover Processes and Monitoring in Urban Areas

Land use and Land cover according to Rawat & Kumar (2015) are two separate terminologies which are often used interchangeably. Land cover refers to the physical characteristics of the earth's surface that encompass distribution of vegetation, water, soil as well as other physical features of the land including those created by human activities such as settlements. On the other hand, land use refers to how humans and their habitat have used land, generally with the accent on the functional role of the land for economic purposes (Rawat & Kumar, 2015). The process of urbanisation is one of the most paramount dimensions of the physical, economic and social changes (Thuo, 2013). According to Mahmood *et al.* (2010), human activities have caused notable changes in the environment for thousands of years. These changes have been amplified by a significant population increase in cities over the last centuries.

Research conducted by Thuo (2010) indicated that approximately 25% of Africa's population lived in towns and cities in 1975; however, due to rapid rural-urban migration by 2000 this number had gone up to 38%, and it's expected to reach 50% by 2050 (Thuo, 2013). According to Li & Lan (2011), with the accelerated urbanization process, there have been drastic changes in land uses due to the high demand for urban land, nevertheless, land is limited within cities, and as a result urban growth has been engulfing the surrounding agricultural areas and small villages around towns (Thuo, 2013). For instance, according to research done by Agarwal (2002) on land use models, it was found

that nearly 1.2 million km^2 of forest and woodland and 5.6 million km^2 of grasslands and pasture had been converted globally.

Agarwal (2002) study attributed these significant changes to human activities. Agarwal further noted that these land-use changes have a paramount implication for future changes in the Earth's climate and, consequently, enormous implications for subsequent land use changes as it will impact ecological trends in cities (Agarwal, 2002). As documented by (Vitousek, 1994) three of the well documented global changes include the increasing concentrations of carbon dioxide in the atmosphere, on-going land-use/ land cover changes and alterations in the biochemistry of the global nitrogen cycle (Kimani & Musungu, 2010).

High-resolution remote sensing technologies are widely used to monitor and map land use changes in cities (Li *et al.*, 2011). Tracking these changes in land use is paramount as it serves as the basis of the urban land use analysis regarding developments that have been made on the land and more importantly changes in the ecological environment, thus, providing a scientific basis for decision making (Bosco *et al.,* 2011). Therefore, maintaining remote sensing database for urban centers is also essential for promoting eco-city construction and sustainable development and as a result led to the improved living environment and social harmony (LI *et al.,* 2011). LUCC are a driving force to climate change due to the influence they have on atmospheric temperatures. Therefore, it is crucial to detect LUCCs accurately, at appropriate scales and on time for researchers to better understand their impacts on climate and provide predictions for earth's future climatic conditions (Mahmood *et al*., 2010; Mundia & Aniya, 2006).

Similarly, information on land use/cover and possibilities for their optimal use are critical for the selection, planning, and implementation of various land use schemes that will serve to ensure that the available land meets the increasing demands for basic human needs as well as their welfare (Rawat & Kumar, 2015). Moreover, this information is crucial as it helps in monitoring the dynamics of land use that have resulted from changing demands of the increasing population. Research by Thuo, (2013) on land use changes in Nairobi

notes significant conversions of land use and cover in Nairobi. This research also highlighted some of the environmental challenges that have been associated with land use conversion in Nairobi including water pollution, soil erosion, waste generation and destruction of vegetation cover. The results of this research are supported by research that was done by Mundia & Aniya, (2006) which attributes these changes to the increased interactions of human activities with the environment amid population increase.

Mundia & Aniya (2006) used multi-temporal Landsat images (1976, 1988 and 2000) together with physical and socio-economic data in a post-classification analysis with GIS to map land use/cover distribution and to analyse factors that could have influenced land use/cover in Nairobi city. The research found that significant land use/ cover have taken place in Nairobi since 1976 and that the built-up area had expanded by about 47% during the study period. The forest covers within the city also had decreased drastically while agricultural lands had increased. This research concluded that there's a need to seek reliable information about land use/cover and their driving forces to be able to plan for Nairobi's development successfully (Mundia & Aniya, 2006).

2.7.1 Relationships between land use policies and climate change

Land use planning and zoning strategies are a predominant part of Local Government's response to mitigation and preparing for climate change management in cities (Bajracharya *et al.,* 2011). The direct impacts of climate change on human land use systems and land occupation could potentially have a range of effects on land access and tenure, with both direct and indirect negative repercussions on human livelihoods, welfare, and prosperity (Quan *et al.,* 2008). Bajracharya *et al.*, (2011) highlighted the need for mitigation and adaptation policies in land use planning context to deal with climate change. Mitigation measures aim to reduce greenhouse gas emissions thus minimising the future impacts of climate change beyond what is already projected (Bajracharya *et al.,* 2011).

Land use planning plays an imperative role in reducing current and future community risks associated with climate change by enhancing both preventions, preparedness responses, and recovery in a society. A study conducted by Bajracharya *et al.* (2011) suggested that, while planning for climate change, it is also important to consider the role of land use to reduce future carbon impacts of new developments and to improve resilience against natural hazards associated with climate. Land use planning and zoning policies can reduce climate change impacts in the following ways:

i. Prohibiting development in high-risk zones via zoning and overlay controls.
ii. Limiting the type of development in high to moderate risk areas for recreation or other forms of public use reducing the potential impacts of natural hazard events.
iii. Applying appropriate development controls in medium and lower risk areas such as minimum elevations, setbacks and lot sizes, as well as maximum densities and site coverage.

Quan & Dyer (2008) provided a framework for assessing land use policies and climate change by giving a five-step analysis as below:

i. The starting point includes identifying the essential elements of climate change, and their effects on land and natural resources use systems which profoundly affected by these impacts.
ii. The second step involves considering the implications of land occupation and systems of landholding as well as the land tenure of climate-induced changes to both land and natural resource system. Land tenure implications can be direct (abrupt or long-term changes in land use hence displacing or significantly affecting human settlements and land-based production systems) or indirect (such as land use changes in agriculture or natural resource utilization) that might drive changes in tenure systems over a period of time.
iii. Thirdly, climate change will lead to spontaneous adaptation by land and resource users, thus, generating the need for systematic adaptation planning by the community at different levels and as a result, affect land tenure systems. These adaptations include agricultural change including changes in cropping zones,

intensification of production systems, greater competition for access to land, water and pasture, economic diversification from dependency on affected resources, urban and rural migration, and policies for improved land use, resettlement, better environmental regulation of land-based resource use, and for protection of natural resources and human settlements.

iv. Tenure implications of mitigation measures should also be considered, including policies avoided deforestation, and development of additional carbon sinks and alternative energy sources including biofuels, which involve significant commercial opportunities for existing and also for new land users

v. Finally the implications for land policies of anticipated climate change – land use impact – adaptation and mitigation – land tenure causal chains for specific types of impact and countries / sub-national regions need to be considered, together with the matter of better integration of land policies with adaptation and mitigation plans and broader national development frameworks. These steps are presented in figure 2.2.

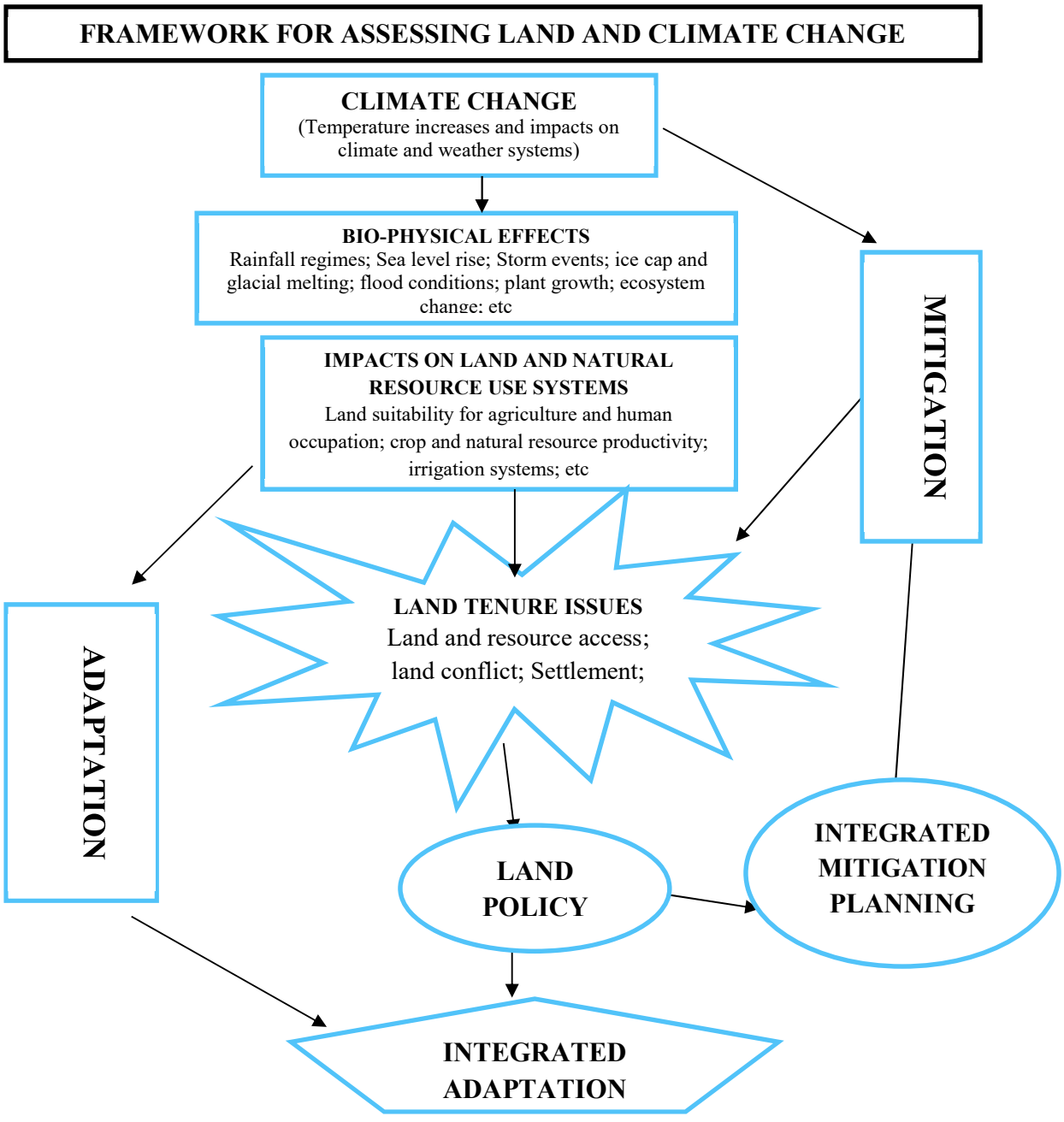

Figure 2. 3: Framework for assessing land and climate change linkages

(Source: Quan & Dyer (2008)

2.7 Climate Change Perception and Management Strategies

Perception is the process by which individuals receive stimuli or information from the environment and modify it into mental awareness (Vedwan & Rhoades, 2001). Public opinion of climate change is influenced by demographic factors such as age, gender, educational status, individual experience with weather patterns, and access to information through the media (Otieno, 2009). People often act based on their perception and as so studying people's opinion is a critical component of socio-political contexts within which policymakers in cities operate (Leiserowitz, 2006; Yu *et al.,* 2013).

Public support or opposition of climate change policies and strategies that include treaties, regulations, taxes, subsidies among others will be influenced significantly by how people perceive the dangers and risks of climate change (Leiserowitz and Pidgeon, 2006). Climate change awareness in Africa is weak as many people are poorly informed about climate change compared with people from developed nations; despite being more vulnerable to climate change effects (Godfrey *et al.,* 2009; Otieno, 2009; Taderera, 2010)

Climate change perception literature in Kenya is mostly in the form of government reports and policy documents such as the NCCRS 2010, NCCAP 2013-2017 and NAP 2015-2030, and it reveals a low level of climate change awareness. According to a study conducted by Otieno *et al.* (2009), it was found that most Kenyans are unaware of climate change concepts and global warming even though they were concerned about frequent drought spells and food scarcity in the country. These study findings are supported by the National Climate Change Response Strategy (2010) and National Climate Change Action Plan (2013-2017) which indicated that a vast majority of Kenyans were unaware of climate change despite their knowledge and awareness of changing weather patterns in the country. The reports recommend more studies to determine the level of climate change awareness among different groups in Kenyan communities to improve insufficient information on climate change perception among Kenyans.

2.9 Knowledge Gaps

From the literature reviewed, there exists a universal consensus across the world that climate change is happening in cities and there is an urgent need for immediate action plans from city managers. The following research gaps were identified.

1. The level of climate change awareness, knowledge and attitude are low in most developing countries even though most people are poor and thus more vulnerable to climate change impacts. Specifically, no study has been undertaken to determine the level of climate awareness in Nairobi city.

2. Despite the evidence of land use/cover change in Nairobi city since its establishment, no single research has focused on establishing the relationship between land use policy change and land use factors in Nairobi.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents a set of methods that were used during the study. It describes the research designs, study population, sampling frame, sample size, data collection tools, data collection methods and procedures, pilot test, data processing, analysis and presentation techniques that were used to assess community's perception, policies and land use factors about climate change processes in Nairobi city.

3.2 Study Area

The study area constituted of Nairobi city, the capital of Kenya. According to the Nairobi County Integrated Development Plan 2018-2022, the city between longitudes 36° 40' and 37° 10'E and latitudes 1° 09' and 1° 28'S covering an area of about 696.1 km^2 which is divided into seventeen (17) sub-counties. This city stands at an altitude of approximately 1,798 above sea level. The city has a relatively cool climate resulting from its high altitude. The temperatures range from 10ºC to 29ºC with a bi-modal rainfall pattern. The long rains season fall between March and May with a mean rainfall of about 899 mm whereas the short rain seasons falls between October and December with a mean of 638mm. The mean annual precipitation is 786.5mm (CIDP, 2018).

Based on the Kenya Population Census of 2009, Nairobi had an approximate population of 3,138, 369 people with an estimated population growth of 4.0%. The primary land cover type varies from grassland scattered with acacia plants to the east of the city to remnants of hardwood forest in the higher areas to the west and land-use is divided into urban use, rangeland, evergreen tropical forests, and agriculture. The mainland use type includes residential areas, industrial/commercial/services centers, infrastructure, recreation, water bodies and the riverine regions, urban agriculture, open lands among others (CIDP, 2018).

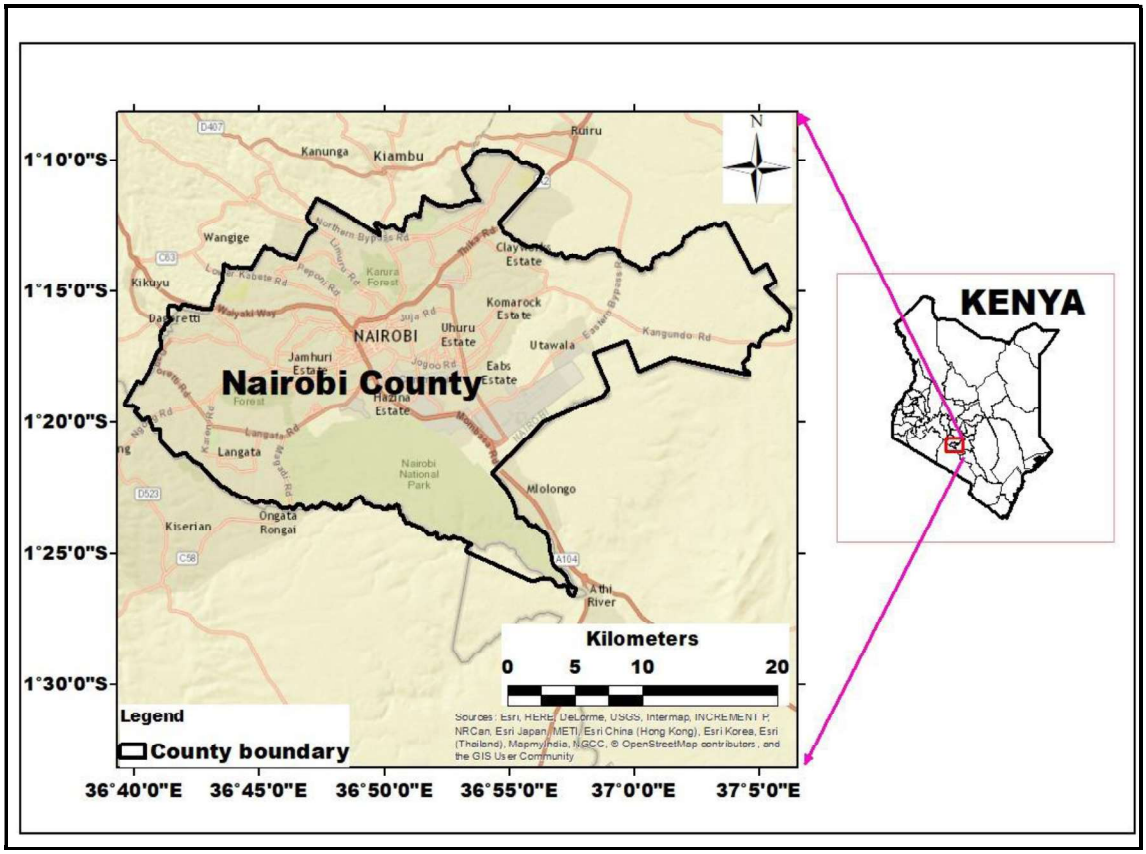

Figure 3. 1: A map of the study area (Source: Google, 2018)

3.3 Research Design

This research adopted a mixed research method which allows the combination of both qualitative and quantitative research methods. This research approach help researchers in understanding the nature of a research problem as it allows confirmation or corroboration of quantitative and qualitative data through triangulation. Most research problems addressed by scientists are complex, and use of either qualitative or quantitative methods by themselves is inadequate (Creswell, 2011). By use of these approaches the researcher collects and analyses persuasively and rigorously qualitative and quantitative data and combines them in a way that gives priority to one or both forms of data thereby complementing each other.

For instance, in this study qualitative approach that is criticised for making it extremely hard to develop a solid statistics because its findings cannot be generalised was complemented by a quantitative approach that provided statistics which could be generalised. The study approach was also advantageous because the statistics yielded from quantitative methods allowed greater precision in reporting results as the qualitative approach enabled extraction of in-depth narratives from information-rich subjects to enhance data interpretation and achievement of the study objectives.

3.4 Sampling frame

The sampling frame for this study was based on the objective of the study. For the community perception, the samples were drawn from the 2009 Kenya National Population Census (KNPC) Report which was acquired from the Kenya National Bureau of Statistics (KNBS) library. According to the 2009 population census, there were 985,016 households within a population of 3.5 million people in Nairobi (KNBS, 2009). The study used the four administrative areas namely Nairobi West, Nairobi East, Nairobi North and Westland in which the population was reported to determine sample sizes. The sample frame for the policies included all active urban planning policies, building codes and by-laws, environmental protection policies, land use policies, and government reports in custody of different government entities. Lastly, the sample frame for the land use/cover processes included all the land under the jurisdiction of Nairobi City County as well as all absolute and active policies and legislation in the department of lands, environmental and forestry, agriculture as well as other relevant national government laws and reports,

3.5 Sampling and sampling techniques

3.5.1 Sample Size

The research data was collected between January 2017 and March 2018. To achieve the first objective of the study, the targeted population comprised of all households (986, 016) in Nairobi City County according to the population census of 2009. From this targeted population, the sample size was determined using Krejci and Morgan formula and table

(Krejcie & Morgan, 1970) designed for large populations and a sample size of 397 households was determined for this study. Estimation of sample size using Krejcie and Morgan is commonly employed in research of this nature, and the following formula is used to determine sample size:

$$S = X^2NP\ (1\text{-}P)/\ d^2\ (N\text{-}1) + X^2P\ (1\text{-}P)$$

S = required a sample size

X2 = the table value of chi-square for one degree of freedom at the desired confidence level

N = the population size

P = the population proportion (assumed to be .50 since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (.05)

Table 3. 1: Sample size distribution in the study area

	Location (Strata)	Total Population (Households)	Formula	No of questionnaires (n)
1.	Nairobi West	212,295	$\frac{Total\ no\ households}{Total\ no.of\ households\ in\ Nairobi} * 404$	87
2.	Nairobi East	369,866	$\frac{Total\ no\ households}{Total\ no.of\ households\ in\ Nairobi} * 404$	152
3.	Nairobi North	327,428	$\frac{Total\ no\ households}{Total\ no.of\ households\ in\ Nairobi} * 404$	134
4.	Wetlands	75,427	$\frac{Total\ no\ households}{Total\ no.of\ households\ in\ Nairobi} * 404$	31
TOTAL		**985,016**		**404**

Policies were reviewed from the existing documents in relevant government organizations which were purposively selected. They included the Ministry of Lands, Ministry of Environment and Natural Resources, Climate Change Secretariat, National Environment and Management Authority (NEMA), County government of Nairobi departments of Urban Planning and environment. Pre-visit were made to each to familiarize the researcher with mandates and policies within each organization in regards to climate change, environmental protection and urban planning.

Afterward, policy and legislation documents and reports addressing climate change, urban planning, land use and zoning, environment and building codes were identified and used as the sample size for this study. Lastly, for the land use policy change, the post-colonial policies, laws, regulations, projects, and initiatives launched by the government(s) at different times at the departments of lands, agriculture, forestry, and environment were selected and reviewed while noting major proposals and changes in each policy document in respect to land use planning. Policies with over four years of implementation were considered and selected with the aid of government officials for review and analysis. Besides, published journal papers on LUCC in Nairobi City County covering between 1976 and 2016 were considered for study of land use/cover processes between the same periods.

3.5.2 Sampling techniques

3.5.2.1 Multi-stage sampling

The population of Nairobi city was divided into four administrative areas (*strata*): namely Nairobi West, Nairobi East, Nairobi North and Westland (KNBS, 2009). From each stratum, systematic sampling was done to select administrative units (divisions) where data was collected (*first stage)*. Within the sampled villages, simple random sampling was done to choose households where the questionnaires were to be administered (*second stage)*. The multistage sampling technique was advantageous for this study because it made it unnecessary to use a list of every household in Nairobi County as the first stage

systematic random sampling allowed a fair distribution of the sample to be achieved thereby allowing a more representation.

In the second phase, a starting point such as the main street within each village was chosen and households selected using simple random techniques along the street. The simple random technique was made to minimise bias and increase representation of the selected sample. Finally, selection of the head of the family at the time of questionnaire from each of the selected household was done to ensure that the data collected from subjects represented their immediate experience to help meet the study objectives.

3.5.2.2 Purposive sampling

Understanding land use and cover change processes in the study area, three published academic papers were purposively selected. The following factors influenced this selection:

1. Author(s) experience and a number of published articles on accredited journals on land use and cover types.
2. Study period covered by the publication and the depth of the research concerning LUCC processes in Nairobi City.
3. Type of land-use and cover classes used for analysis of LUCC processes.

The selected papers were categorised into the following analytical case studies:

1. Case study 1: Assessment of landscape change and occurrence at watershed level in the city of Nairobi by Bosco *et al.* (2011)
2. Case study 2: Dynamics of Land-use/cover changes and degradation of Nairobi city by Mundia and Aniya (2006).
3. Case Study 3: The implication of Land use and land cover dynamics on the environmental quality of Nairobi city by Oyugi *et al.* (2017).

The purposive approach was advantageous for this study as it allowed the selection of analytical studies with a very strong academic basis for qualitative analysis of land use/cover processes.

3.6 Data collection instruments and procedures

Three data collection tools were used to collect data for the study. The questionnaire was used for quantitative data collection whereas policy checklist and analytical case studies were used to collect qualitative data from the policy documents and selected academic papers.

3.6.1 Questionnaire tool

A questionnaire was developed and administered by the researcher and ten (10) trained research assistants to the sample households. The questionnaire gauged the respondents' awareness, knowledge and attitude on climate change in cities as well as their preference for different adaptation and mitigation plans. The socio-demographic information about the respondents was also collected including their, gender, age, educational status, number of years lived in Nairobi, location as well as their occupations. A set of questions assessed climate change awareness among respondents, sources of climate information, perceived causes of climate change, signs of climate change in their environment, concerns of respondents on climate change as well as perception on different policy statements drawn from different urban sectors (Table 3.2).

Table 3. 2: Main themes of survey questionnaires

Criterion	Groups of Questionnaires Survey	Type of Response	Description & Role
The demographic characteristics	Respondents personal information	Choice and Open	To understand the social demographic characteristics of the respondents.
Climate change knowledge	Have you heard or read about climate change	Choice (Yes, No, I don't know)	To assess the respondent's awareness.
	Sources of Climate Change information.	Dichotomous (Yes or No) among listed sources.	To determine the favourite sources of information and their influence among respondents.
	Influence of Climate information sources	Likert scale (A lot, A little, Not very much, Not at all).	
Climate change impacts	How well you understandnd climate change?	Likert Scale (Very well, Fairly well, Not very well, Not at all).	To assess how respondents understand climate change in cities.
	Climate change contributors to cities.	Likert Scale (High, Moderate, Not Sure).	
	Signs of climate change in cities.	Likert Scale (1-5)	
	Climate Change threat to personal health and safety.	Likert Scale Rating	To assess how respondents relate climate change to life
Adaptation and Mitigation strategies	Worry about climate change.	Likert Scale Rating	To identify issues of concern to help formulate response strategies
	Concern about climate change.	Likert Scale Rating	
	Agreement with Policy and Legislation Statements.	Likert Scale Rating	

3.6.2 Policy checklist

A policy checklist for policy assessment was developed after a thorough literature review on the desirable international practices in land use planning, urban planning designs, site planning and building codes for climate change management.

3.6.3 Land use/ land cover change and policies

The three analytical case studies outlined in section 3.5.2.2 were used to collect data on land use/cover change from 1976 to 2015. Data collected from the case studies included land use/cover classes and land use/cover change statistics in 1976, 1988, 1995, 2000, 2005, 2010 and 2015.

3.7 Data collection

Data collection started with the training of research assistants on contents of the questionnaires tool including how to select households, how to approach the respondents and inform them the purpose of the survey and ethical issues related to the study including the provision of accurate information as well as seeking the consent of respondents before administering questionnaires to them. The data collection exercise started on July 15, 2018, and ended on July 28, 2018, with a pilot test at Uhuru Park, Central Park, and Jevanjee gardens to check appropriateness, precision, and clarity of the questions in providing essential data. After the pilot test changes were made on the questionnaire tools to remove the ambiguity of some questions. During the data collection exercise, the principal researcher ensured quality control of data collected by monitoring the performance of data collectors and regular checks of data collected to evaluate completeness.

These checks helped to ensure that no data was missing and detecting errors. It took five to seven minutes for the participants to answer the questionnaire and ensure that it genuinely reflected their immediate experience on climate change. The surveys were conducted on weekdays between 9 a.m. and 5 p.m. For the second objective, data collection involved an extensive and focused policy review on the selected policy and legal documents against the checklist. Where a policy document had addressed a given planning practice a score of “1” was awarded and a score of “0” where it did not address. Words such as may, should prefer, suggest, encourage indicated the suggestive nature of the policy while mandated, shall, must and will meant mandatory policies. Lastly, for the third objective, a critical review of the three analytical case studies was undertaken to inform

land use/cover changes in Nairobi City County between the study periods. Major LUCC were noted including area coverage, percentage change and rate of change and major LUCC conversion. A focused policy review was also done to determine significant policy proposal, and implementation against major LUCC decoded from the three analytical case studies.

3.8 Data processing, analysis, and presentation

As quantitative and qualitative data were collected for this study integration methods (merging, connecting and embedding data) were used to combine qualitative data in the form of texts (narratives) with the quantitative data in the form of descriptive statistics. This was achieved by reporting the quantitative statistical results first then using qualitative literature to support or refute the quantitative results as recommended by Creswell, (2011). Statistical Package for Social Scientists (SPSS) series 24 was used for data analysis.

All completed questionnaire were investigated for completeness and consistency, then a numerical coding of qualitative responses was done for ease of storage and analysis. The binary codes were entered into SPSS, and analysis commands ran to test on climate awareness, perception, and preference to long-term mitigation strategies for climate change impacts. Data analysis involved both simple descriptive such as frequency counts, percentages, means and standard deviations to summarise the data and inferential statistics such as correlation analysis, chi-square, Kruskal and Mann-Whitney tests to determine the statistical significance of respondents' social-demographic characteristics to significant issues that were investigated in this study. The statistical tests were tested at a confidence level of 95%, 99%, and 99.9% respectively.

For the policy analysis, the data collected was entered into Microsoft Excel software and policy score was calculated by summing up the number of policy documents that had addressed a given planning practice while the relative policy coverage (percentiles) was

calculated as ratio between policy score against maximum number of counts as shown in formula below (Grover, 2010).

P= IPS/N* 100

Where,

P: Percentage score.

PS: Policy Score.

N: Maximum number of score

3.7.1 Dependent Variables: Planning Practices

The dependent variable was used to measure the suitability and contribution of different sampled policies to climate change management in Nairobi city.

3.7.2 Independent Variable: Climate change management plan quality

This variable was conceptualized as a measure of climate change management ability of the sampled policies to responding to climate change impacts of Nairobi city. For instance, planning practice encouraging mixed land use and high-density development result in reduced use of vehicles and as a result, minimize vehicular emission. Lastly, the data collected from the analytical case studies were entered using Microsoft Excel software for statistical analysis. Simple descriptive analysis such as frequencies and percentiles were used to summarize the results in tables and bar graphs to reveal land use /cover processes at different times of the study period. For the policies, a qualitative approach was used to understand how and to what extent different policy actions had influenced land use/cover types. Further, this approach was used to explain the relationship between different policy actions and land use/cover processes.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Community perception and mitigation preferences for climate change among the residents of Nairobi

4.1.1 Social-demographic profile of respondents

The summary results for the socio-demographic characteristics of respondents are as presented in Table 4.1. The sampled population consisted of 55.2% (n = 291) males and 44.8% (n= 178) female. Gender is a good predictor of climate change because different genders are affected differently by climate change, and hence both groups could have a different perspective on climate change issues (McCright, 2010). Majority 32.7% of the respondents were below 24 years and between 25 to 34 years (31.5%) of age. Age is an important predictor of respondent's familiarity with weather events, and studies have shown a positive correlation between age and climate change familiarity (Ochieng & Koske, 2013; Saroar & Routray, 2010).

Majority 54.4% of the respondent had attained tertiary education (colleges and universities) followed by 35% with secondary education. Educational status is seen as another major predictor of public knowledge and attitude. Studies on climate change have shown that people with high level of education were likely to be informed on climate change issues (Aquah, 2011; Adebayo *et al.,* 2013). The majority 32% of the residents had lived in Nairobi for less than five years. The number of the year lived in a particular area could probably reflect an individual's experience with climate change events in that area (Table 4.1).

Table 4.1: Overall socio-demographic characteristics

Characteristics	Category	Frequency	Percentage (%)
Gender	Males	219	55.2
	Females	178	44.8
	Total	**397**	**100**
Age Group	< 24	130	32.7%
	25-34	125	31.5%
	35-44	87	21.9%
	45-54	36	9.1%
	> 55	19	4.8%
	Total	**397**	**100**
Educational Status	Primary	42	10.6%
	Secondary	139	35%
	Tertiary	216	54.4%
	Total	**397**	**100**
Years Lived in Nairobi	< 5	127	32%
	6-10	85	21.4%
	11-15	40	10.1%
	16-20	62	15.6%
	> 20	83	20.9%
	Total	**397**	**100**

4.1.2 Level of climate change and variability awareness among respondents

Table 4. 2: Climate change awareness among the respondents in Nairobi

Response Category	Frequency	Percent
Heard about climate change	364	91.7%
Never heard about climate change	31	7.8%
Don't Know whether they heard	2	0.5%
Total	**397**	**100.0**

The majority (91.7%; n =364) of the respondents had heard about climate change while 7.8% (n= 31) had not heard about it (Table 4.2). The findings of this study support other studies which indicate that public awareness on climate change has increased tremendously, for example, a survey conducted by Lorenzoni and Pidgeon (2006) to collect public views on climate change in Europe and USA found that public awareness had increased significantly from 65% in the early 1990s to over 72% in early 2000s. Therefore, 91.7% awareness level among Nairobi residents could mean that both international and local climate change awareness is on the rise and more people are becoming aware of climate change. A statistical summary showing the differences in climate change knowledge between different demographic groups is shown in Table 4.3

Table 4. 3: Differences in climate change knowledge among different socio-demographic groups in Nairobi

Social-Demographic Groups		Knowledge status		
		Yes	No	I don't know
Gender	Male (n =219)	89.0%(195)	10.5%(23)	0.5% (1)
	Female (n =178)	94.9% (169)	4.5%(8)	0.9% (1)
	Chi square	p = 0.085ns		
Educational status	Primary (n =42)	78.6%(33)	21.4% (9)	0% (0)
	Secondary(n =139)	91.4% (127)	8.6%(12)	0% (0)
	Tertiary(n=216)	94.4% (204)	4.6(10)	0.9% (2)
	Kruskal test	$\chi^2(2) = 11.384, p = 0.003$***		
Age group	< 24 (n =130)	93.1%(121)	6.2%(8)	0.7%(1)
	25-34 (n =125)	89.6%(112)	10.4%(13)	0.0%(0)
	35-44 (n =87)	92.0%(80)	6.9%(6)	1.1%(1)
	45-54 (n = 36)	91.7%(33)	8.3%(3)	0.0%(0)
	> 55 (n = 19)	94.7%(18)	5.3%(1)	0.0%(0)
	Kruskal test	$\chi^2(4) = 1.232, p = 0.873$ns		
Number of Years lived in Nairobi	< 5 (n = 127)	89.8% (114)	8.7%(11)	1.6%(2)
	6-10 (n =85)	92.9% (79)	7.1%(6)	0.0%(0)
	11-15 (n =40)	90.0%(36)	10.0%(4)	0.0%(0)
	16-20 (n =62)	90.3% (56)	9.7%(6)	0.0%(0)
	> 20 (n =83)	95.2(79)	4.8%(4)	0.0%(0)
	Kruskal test	$\chi^2(4) = 4.782, p = 0.31$ns		

A positive climate change awareness was found across all groups outlined in Table 4.3. There was no statistical differences in age group ($\chi^2 = 1.232$, $df = 4$, $p = 0.873$) and the number of years a respondent had lived in Nairobi ($\chi^2 = 4.782$, $df = 4$, $p = 0.31$) *and* level of climate change awareness. However, a statistical difference ($\chi^2 = 11.384$, $df = 2$, $p = 0.003$) was found between the level of awareness and the educational status of the respondents; probably, because majority 54.4% of respondents had attained tertiary education. These results support a study conducted by Oruonye (2011) which found that students in tertiary levels of education were more aware of climate change based on the question that asked whether the respondents had heard about climate change before. The

results of this study also support other studies by Aquah (2011) and Adebayo et al., (2013) which singled out educational status as the main predictor of climate change awareness.

While results of this study may be taken to mean that majority of Nairobi's residents are incredibly aware of climate change such a conclusion might be misleading because hearing about climate change does not translate to understanding deep issues related to it. This interpretation can be confirmed by a study done by Oruonye (2011) which revealed that the majority of college/university students were aware of climate change based on the survey question whether they heard of it before. A further probe of same respondents revealed that majority (89%) them did not understand deep issues of climate change thus arriving into a conclusion that majority of students in high levels of education in Jalingo Metropolis had low awareness on climate change. To overcome this challenge, respondents of this study were subjected to more focused and objective questions to reveal their level of knowledge and perception on climate change to make a more informed decision about their perception and understanding of climate change in cities.

4.1.3 Understanding climate variability and climate change

Majority 28.5% and 51.9% of the respondents in Nairobi felt that they understood climate change very well and fairly well respectively. While a minority 8.85% felt that they did not understand at all (Table 4.4).

Table 4. 4: Level of climate change understanding among respondents in Nairobi

Response	Frequency	Percentage (%)
Very well	113	28.5
Fairly well	206	51.9
Not very well	43	10.8
Not at all	35	8.8
Total	**397**	**100**

Table 4. 5: Differences in climate change understanding among different socio-demographic groups in Nairobi

Social-Demographic Groups		Level of understanding climate change			
		Very well	F. well	Not v. well	Not at all
Gender	Male (n =219)	32.0% (70)	48.9% (107)	37.0%(34)	3.7%(8)
	Female (n =178)	24.2% (43)	55.6% (99)	18.5% (33)	1.7% (3)
	P value	0.182ns			
Educational status	Primary (n =42)	23.8%(10)	42.9%(18)	33.3% (14)	0.0% (0)
	Secondary(n =139)	26.6%(37)	48.2%(67)	20.9% (29)	4.3%(6)
	Tertiary(n=216)	30.6%(66)	56.0% (121)	11.1%(24)	2.3%(5)
	Kruskal Test	$\chi^2(2) = 6.802$, $p = 0.033$*			
Age group	< 24 (n =130)	21.5%(28)	59.2%(77)	15.4%(20)	3.8%(5)
	25-34 (n =125)	33.6%(42)	44.0%(55)	19.2%(24)	3.2%(4)
	35-44 (n =87)	35.6%(31)	52.9%(46)	11.5%(10)	0%(0)
	45-54 (n = 36)	19.4%(7)	61.1%(22)	16.7%(6)	2.8%(1)
	> 55 (n = 19)	26.3%(5)	31.6%(6)	36.8%(7)	0.5%(1)
	Kruskal Test	$\chi^2(4) = 8.837$, $p = 0.065$ns			
Number of years lived in Nairobi	< 5 (n = 127)	29.1% (37)	53.5% (68)	14.2% (18)	3.1(4)
	6-10 (n =85)	31.8%(27)	47.1% (40)	15.3%(13)	5.9%(5)
	11-15 (n =40)	37.5% (15)	45.0%(18)	12.5%(5)	5.0% (2)
	16-20 (n =62)	21.0%(13)	61.3%(38)	17.7%(11)	0%(0)
	> 20 (n =83)	25.3%(21)	50.6%(42)	24.1%(20)	0%(0)
	P (value)	$\chi^2(4) = 0.493$, $p = 0.974$ns			

Educational status (χ^2 = *6.802, df =2, p* = 0.033*) influenced respondents' level of understanding issues concerning climate change and variability; meaning that educational status improved an individual's understanding of climate change and variability compared to other social demographic attributes (Table 4.5). The findings of this study support other studies done by Aquah (2011) and Adebayo *et al.* (2013) which pointed out education as a significant predictor of the level of awareness and knowledge on climate change and variability. Thus, according to this study, it is highly probable that someone who had achieved a high level of education was more likely to have some deep understanding of climate change and variability issues as well as management practices that can be used to control climate change in an urban setting. Additionally, these groups are more likely going to embrace and support any mitigation strategies and policy framework that sought to find a short and long-term solution to climate change.

4.1.4 Perception on the causes of climate change and variability

Apart from knowing how well respondents understood climate change in cities, knowledge of specific factors that are responsible for climate change in cities is another measure of public awareness of urban climate change. This objective was achieved by presenting respondents with a list of factors that majorly contribute to climate change in cities for them to indicate their level of agreement with each factor. Results of the analysis of the responses are presented in Table 4.6. Vehicular emission emerged as the most significant cause of climate change, and variability supported by 758% (n= 301) of the respondents followed closely by the destruction of green spaces and forests that was supported by 74.3% (n = 295) of the respondents. Industrial emission received approval of 71% followed by population growth, and urbanization rates received approval of 70% from the respondents.

Table 4. 6: Respondents perception of causes of climate change and variability in Nairobi

Factor	Category	Frequency	Percent (%)	Factor	Category	Frequency	Percent (%)
Population growth	High	278	70.0	**Rate of Urbanization**	High	279	70.3
	Moderate	86	21.7		Moderate	102	25.7
	Not Sure	33	8.3		Not Sure	16	4.0
Destruction of green spaces	High	295	74.3	**Vehicular emissions**	High	301	75.8
	Moderate	73	18.4		Moderate	79	19.9
	Not Sure	29	7.3		Not Sure	17	4.3
Poor solid waste management	High	268	67.5	**Industrial emissions**	High	282	71.0
	Moderate	107	27.0		Moderate	98	24.7
	Not Sure	22	5.5		Not Sure	17	4.3
Poor drainage systems	High	221	55.7	**Poor land planning policies**	High	206	51.9
	Moderate	141	35.5		Moderate	130	32.7
	Not Sure	35	8.8		Not Sure	61	15.4

Results of this study revealed that respondents were aware of the causes of climate change and variability in urban areas though knowledge gaps between different causes were evident. On global context, a study by Lorenzoni & Pidgeon (2006) revealed that most citizens in the United States and Europe had no clear understanding of various causes of climate change and variability as many respondents indicated deforestation and air pollution as main causes despite them being secondary to the burning of fossil fuels.

On the contrary, this study revealed that majority of residents in Nairobi were aware of the contribution of fossil fuel burning and deforestation in driving climate change and variability thereby supporting a research by Ochieng & Koske (2013) which showed that majority of Kenyans viewed destruction of forests and pollution as significant drivers of

climate change. The authors further opined that Kenyans understood climate change based on their daily environmental experiences and thus global aspects of climate change like GHG emissions remain abstract in their understanding. Respondents' of this study expressed limited knowledge on the role of land use and zoning policies, and drainage control with an approval rating of 51.5% and 55.7% respectively about climate change in cities. This could be interpreted to mean that respondents of this study had a limited understanding of the role of land use policies in climate change management.

Additionally, these results could be interpreted to mean that most Nairobi residents are only aware of climate change drivers that are directly linked with pollution (industrial and vehicular emissions), population and urbanization growth. Also, these results show a limitation in knowledge about different causes of climate change and variability because, for instance, land policies stand at the heart of climate change in cities as they influence all other critical sectors linked with climate change in cities such transport orientation and resource management (OECD, 2010). Also, poor land use policies could mean un-prioritized land allocation including green spaces, poor transport networks indicating more traffic problem and as a result of more emissions among others (OECD, 2010). On the other side, inadequate drainage systems may also lead to flooding in cities due to blocked drainage channels and result in more casualties and spread of waterborne diseases such as cholera.

4.1.5 Perception of signs and effects of climate change and variability in Nairobi

Table 4. 7: Respondents agreement level with various signs and effects known to relate to climate change

Factors		RESPONSES									
		Strongly agree		Agree Moderately		Somewhat Agree		Not Agree		Strongly Disagree	
		F	%	F	%	F	%	F	%	F	%
Signs	Temperature fluctuations	244	61.5	122	30.7	23	5.8	7	1.8	1	0.3
	Extended dry seasons	246	62.0	111	28.0	24	6.0	13	3.3	3	0.3
	Extended cold seasons	207	52.1	117	29.5	44	11.1	22	5.5	7	1.8
	Change in rain pattern	258	65.0	80	20.2	38	9.6	15	3.8	6	1.5
	Flooding in rainy seasons	187	47.1	113	28.5	49	12.3	35	8.8	13	3.3
Effects	Spread of diseases e.g. cholera	208	52.4	107	27.0	36	9.1	35	8.8	11	2.8
	Water scarcity	232	58.4	103	25.9	38	9.6	19	4.8	5	1.3
	Price fluctuations	201	50.6	99	24.9	48	12.1	35	8.8	14	3.5
	Human-human	105	26.4	85	21.4	70	17.6	96	24.2	41	10.3
	Human- animal	108	27.2	86	21.7	78	19.6	94	23.7	31	7.8
	Migrations	166	41.8	84	21.2	74	18.6	49	12.3	24	6.0

The outcome of these results showed that the majority 92.2% (strongly agree and agree moderately) of the residents perceived temperature fluctuations as the main sign of climate change and variability. This was followed by 90% and 85.2 % of residents who perceived extended dry seasons and change of rain patterns as the vital signs respectively. Similar to the results of the causes of climate change and variability, it was confirmed that residents perceived signs that seemingly interfered with their day-to-day activities as significant signs of climate change. These results are supported by a study by Hares *et al.* (2010) which found that the most dominant understanding of climate change and variability was

linked to changes in weather patterns that survey participants had personally observed in their lifetime

Similarly, a study by Lorenzoni & Pidgeon (2006) revealed that most studies on climate change perception had indicated some shared views across the world. In particular, the study found that there are widespread awareness and concern about climate issues. On the contrary, the study found limited understanding of causes and solutions to climate change, perceived psychological, temporal and spatial distant threats on climate change and some willingness to address the perceived threats through defined measures as well as the ascription of individual responsibility to take steps against climate change.

Perception and understanding of the effects of climate change and variability revealed that majority 84.3% (strongly agree and agree moderately) of the residents perceived water scarcity as the significant effects. This was followed by 79.4% and 75.4% of respondents who felts that spread of diseases and price fluctuations of agricultural commodities respectively were immediate effects of climate change and variability. On the lower end, human-human conflict, human-animal conflicts, and migrations from one area to another due to limited resources received approval ratings of 47.8%, 48.9%, and 63.0% respectively (Table 4.7). Again, these results revealed the constant knowledge gap and low interpretation of deep issues related to climate change among residents of Nairobi.

Evidently, respondents seemed to continually rate issues that affected them daily high compared to those which affected them based on the season of the year. For instance, due to water scarcity in 2017 many cholera cases were reported in Nairobi (GoK, 2017; WHO, 2017) implicating spread of waterborne infectious diseases. Also, there have been significant fluctuations in prices of essential agricultural food commodities (Agricultural and Food Authority, 2018) due to poor rains that have been experienced in the country. Although climate change and variability factors could have played a significant contribution to different pricing, other pressing issues such as unemployment and political situation could have masked this influence.

4.1.6 Individual attitude towards climate change among Nairobi's residents

Table 4. 8: Level of personal worry about climate change in Nairobi

Level of Worry	Frequency	Percent
Great deal	187	47.1
A fair deal	138	34.8
Only a little	61	15.3
Not at all	11	2.8
Total	**397**	**100.0**

Majority 47.1% of the respondents were greatly worried about climate change and variability followed by 34.8% who were worried to a fair deal (Table 4.8). Results of this study could be interpreted to mean that the majority of residents in Nairobi City County are greatly worried about climate change and variability. Results of this study, support other studies which have been undertaken to examine the trend in worry and concern about climate change to provide a general indication of how people view matters of climate change. Notably, studies conducted in 1988 in the 12 European Countries member states showed that 76% of the respondents were very/somewhat worried about climate change. Another study in 2002 showed that Europeans were worried about future changes in climate change though despite the high level of concern detected in these studies, the importance of climate change remained a secondary compared other environmental, personal and social issues (Lorenzoni and Pidgeon, 2006).

Educational status (0.007***) and age group (0.007***) significantly influenced the respondent's level of worry on climate change and variability (Table 4.9). This results in support study by Ochieng (2010) which singled out age and educational status as crucial factors in understanding climate change and variability based on personal experience with weather and amount of information one gets from education. Therefore, the results of this study can be interpreted to mean that respondents within this socio-demographic brackets

are likely going to see climate change and variability as a threat in their life and perhaps take any necessary actions to adapt to it.

Table 4. 9: Differences in level of personal worry on climate change among different socio-demographic groups

Social-Demographic Groups		Level of personal worry			
		Great deal	**A fair deal**	**Only a little**	**Not at all**
Gender	Male (n =219)	47.0%(103)	33.8%(74)	15.1%(33)	4.1%(9)
	Female (n =178)	47.2%(84)	36.0%(64)	15.2%(27)	1.7%(3)
	P value	0.564ns			
Educational status	Primary (n =42)	35.7%(15)	35.7%(15)	21.4%(9)	7.1%(3)
	Secondary(n =139)	41.7%(58)	35.3%(49)	19.4%(27)	3.6%(5)
	Tertiary(n=216)	52.8%(114)	34.3%(74)	11.1%(24)	1.9%(4)
	Kruskal-Wallis	$\chi^2(2) = 10.015$, $p = 0.007$***			
Age group	< 24 (n =130)	58.5%(76)	27.7%(36)	13.1%(17)	0.8%(1)
	25-34 (n =125)	42.4%(53)	34.4%(43)	17.6%(22)	5.6%(7)
	35-44 (n =87)	46.0%(40)	40.2%(35)	12.6%(11)	1.1%(1)
	45-54 (n = 36)	33.3%(12)	52.8%(19)	11.1%(4)	2.8%(1)
	> 55 (n = 19)	31.6%(6)	26.3%(5)	31.6%(6)	10.5%(2)
	Kruskal-Wallis	$\chi^2(4) = 14.142$, $p = 0.007$***			
Number of years lived in Nairobi	< 5 (n = 127)	50.4%(64)	37.8%(48)	10.2%(13)	1.6%(2)
	6-10 (n =85)	38.8%(33)	37.6%(32)	17.6%(15)	5.9%(5)
	11-15 (n =40)	52.5%(21)	30.0%(12)	15.0%(6)	2.5%(1)
	16-20 (n =62)	53.2%(33)	32.3%(20)	11.3%(7)	3.2%(2)
	> 20 (n =83)	43.4%(36)	31.3%(26)	22.9%(19)	2.4%(2)
	Kruskal-Wallis	$\chi^2(4) = 4.964$, $p = 0.291$ns			

Table 4. 10: Level of concern on climate change and variability in Nairobi among respondents

Level of concern	Frequency	Percent
Very concerned	197	49.6
Fairly concerned	149	37.5
Not very concerned	42	10.6
Not at all concerned	4	1.0
I don't know	5	1.3
Total	**397**	**100.0**

Majority 49.6% and 37.5% were very and fairly concerned about climate change and variability in Nairobi. Similar to the results of the level of personal worry on climate change and variability (Table 4.10), the majority of the respondents expressed great concerns on climate change and variability. This is also a positive indication that the majority of Nairobi resident are greatly worried and at the same concerned about climate change and variability. The level of concern was significantly influenced by educational status *(χ^2=7.592, df =2, p = 0.022*)* of the respondents (Table 4.11).

Even though age did not influence one's level of concern *(χ^2=7.230, df =4, p* = 0.124) as some studies have previously indicated, the findings of this study are consistent the results of Owolabi *et al*. (2012) and Saroar & Routray (2010) suggesting that age group influenced personal worry and concern about climate change on the respondents (Table 4.9; Table 4.11). Also, studies have shown that age affects personal experience with different climatic conditions and as such old people are likely going to view climate change differently from young, inexperienced people.

Table 4. 11: Differences in level of personal concern on climate change among different socio-demographic groups

Social-Demographic Groups		Level of concern				
		Very concerned	**F. concerned**	**Not v. concerned**	**Not at all concerned**	**I don't know**
Gender	Male (n =219)	48.4%(106)	38.8%(85)	11.0%(24)	0.9%(2)	0.9%(2)
	Female (n =178)	51.1%(91)	36.0%(64)	10.1%(18)	1.1%(2)	1.7%(3)
	Mann-Whitney	0.681ns				
Educational status	Primary (n =42)	38.1%(16)	33.3%(14)	21.4%(9)	4.8%(2)	0.5%(1)
	Secondary(n =139)	46.8%(65)	39.6%(55)	12.9%(18)	0.7%(1)	0.0%(0)
	Tertiary(n=216)	53.7%(116)	37.0%(80)	6.9%(15)	0.5%(1)	1.9%(4)
	Kruska Wallis	$\chi^2(2) = 7.592$, p = 0.022*				
Age group	< 24 (n =130)	58.5%(76)	32.3%(42)	6.9%(9)	0.0%(0)	2.3%(3)
	25-34 (n =125)	47.2%(59)	38.4%(48)	10.4%(13)	2.4%(3)	1.6%(2)
	35-44 (n =87)	47.1%(41)	37.9%(33)	14.9%(13)	0%(0)	0%(0)
	45-54 (n = 36)	36.1%(13)	50.0%(18)	13.9%(5)	0.0%(0)	0.0%(0)
	> 55 (n = 19)	42.1%(8)	42.1%(8)	10.5%(2)	5.3%(1)	0.0%(0)
	Kruskal Wallis	$\chi^2(4) = 7.230$, p = 0.124ns				
Number of Years lived in Nairobi	< 5 (n = 127)	48.8%(62)	40.9%(52)	9.4%(12)	0.0%(0)	0.8%(1)
	6-10 (n =85)	45.9%(39)	36.5%(31)	14.1%(12)	2.4%(2)	1.2%(1)
	11-15 (n =40)	47.5%(19)	45.0%(18)	7.5%(3)	0.0%(0)	0.0%(0)
	16-20 (n =62)	59.7%(37)	35.5%(22)	3.2%(2)	1.6%(1)	0.0%(0)
	> 20 (n =83)	48.2%(40)	31.3%(26)	15.7%(13)	1.2%(1)	3.6%(3)
	Kruskal Wallis	$\chi^2(4) = 3.137$, p = 0.535ns				

4.1.7 Preferences to long-term mitigation climate change and variability management strategies

A mean of *1 to 2.5* indicates that the element in intervention has been adapted to a small extent while a mean of *2.6 to 5* shows that the factor has been employed to a large extent.

Table 4. 12: Calculated mean score as assigned by respondents on their rating of response strategies to the effects of climate change

Policy Statement	N	Mean	Std. Deviation
Protecting sensitive areas such as wetlands and forests	397	4.66	0.684
Encouraging maintenance of drainage systems in the city.	397	4.59	0.759
Promoting proper waste management techniques.	397	4.56	0.804
Encouraging water management technologies such as water harvesting.	397	4.52	0.787
Embracing green planning in streets, parks, open spaces, gardens, etc.	397	4.47	0.883
Promote low carbon technologies in cities.	397	4.44	0.935
Encourage use of public/transit mass transport.	397	4.43	0.809
Encouraging research to enhance climate change understanding and appreciation.	397	4.40	0.92
Promoting waste-energy capture technologies.	397	4.39	0.977
Encouraging public participation in matters related to environment and climate.	397	4.38	0.969
Embracing effective traffic management technologies.	397	4.38	0.831
Doing housing reforms in informal settlements.	397	4.35	0.904
Encouraging use of Liquid Propane Gas (LPG) stoves.	397	4.34	0.911
Encouraging solar installation and water heaters in buildings.	397	4.34	0.92
Embracing the use of weather and climate information in developments.	397	4.32	0.949
Encouraging compliance with existing policies and legislation.	397	4.28	1.027
Strengthening the capacity of national and county institutions responsible for climate change.	397	4.27	1.114
Encouraging research to identify design and materials that enhance the resilience of infrastructure.	397	4.26	1.065
Encourage the use of non-motorized modes of transport.	397	4.23	0.914
Promoting the construction of climate-proof infrastructure, e.g., roads	397	4.21	1.098
Adopting SMART building technologies such as green buildings	397	4.18	1.085
Encouraging mixed land use planning.	397	4.16	0.999
Overall Mean		**4.37**	

The results of this study show that Nairobi residents are aware of different mitigation strategies although gaps in their knowledge are evident. The respondents recorded an overall mean score of 4.37 meaning that they were aware of various mitigation and adaptation strategies (Table 4.12). Overall, the majority of the respondents seemed to agree or strongly agree with the strategies presented in the questionnaire, but still, there was some substantial minority who disagreed or said “don’t know” with various strategies, thus, indicating limited knowledge on climate change issues in cities.

Comparing the nature of strategies presented to respondents, majority of them seemed to agree with policies that are directly linked with their daily environmental issues such as, protection of sensitive areas such as Nairobi's river bank, forests, watersheds and other reserved areas from encroachment" which received their highest approval with a mean of 4.66 (SD= 0.684). This policy was followed closely by “Encouraging proper maintenance of drainage systems to manage flooding in rainy seasons” (M= 4.59, SD= 0.759) and “Promoting proper waste management techniques to reduce drainage blockages and emissions from wastes” **(**M=4.56, SD= 0.804). “Encouraging water management technologies among city residents such as water harvesting, good water usage in households” was represented with a mean of 4.52, SD= 0.787 (Table 4.12).

Waste management, drainage issues after light rain showers, water scarcity, and destruction of protected areas have been affecting Nairobi residents more often the reason as to why manage strategies related to them could have received high approval from the residents. The study established a knowledge gap in among mitigation management strategies majorly because their action plans could be indirect and thus difficult for an average person to interpret. For instance, “Mixed *land use development”* with a mean of 4.16 (SD= 0.999) was the least preferred management strategy despite its immense role in climate change intervention in cities. For example, adequate land use and zoning policies and strategies would ensure the effectiveness of the transport sector by encouraging mixed developments plans thus reduced trips translating to reduced vehicular emissions and a general reduction in GHG emission.

Also, these management strategies would ensure adaptation strategies are affected including preserving of land resources such as forests, providing for more open spaces and green spaces within the cities (OECD, 2010). Other mitigation management strategies such as the use of green building technologies, construction of climate-proof infrastructure, use of non-motorized modes of transport among different indirect management strategies also received a low rating thus attesting low understanding of the immeasurable role these strategies can play in climate management in cities. To align Nairobi city with global climate change interventions envisaged by the Sustainable Development Goals, especially Goal 11 which promotes sustainable cities and communities as well as calls made by the UN habitant III: The new urban agenda (2016), these intervention strategies must be embraced in Nairobi city to deal with current and future climate change and variability challenges.

4.2 Existing urban planning and building design policies in relation to climate change and UHI management in Nairobi city

4.2.1 Land use and zoning policies

Table 4. 13: Land use and zoning policies

Planning Practice	Policy Coverage Assessment			Policy Quality Assessment			
	Policy Addressed		Relative Policy Coverage (%)	Not Detailed		Detailed	
	No	Yes (a)		N	% (a)	N	%(a)
Encourages mixed land use development	12	3	20	1	33.33	2	66.67
Encourages future development through effective land management and development regulations	11	4	26	2	50	2	50
Promotes zoning regulation to create more green / open space	13	2	13.3	1	50	1	50
Promotes principles of land conservation such as sustainable use of land	9	6	40	2	33.33	4	66.67
Encourages development of local area development plans in urban	11	4	26.6	2	50	2	50

Promoting principles of land conservation such as sustainable use of land was addressed by the majority of policies with a relative coverage of 40.0%. It was also well detailed by 66.67% of policies which had addressed it. Development of local area development plans for urban areas and planning for future growth through effective land management and regulation each with a relative coverage of 26.6% were also relatively detailed by 50.0% of the policies which had addressed them. Mixed land use development had a relative

coverage of 20%, but it was well detailed by 66.67% of the policy documents that had discussed it. Lastly, zoning regulation to create more green and open spaces was poorly discussed with a relative coverage of 13.3% although, 50% of the policy documents discussing it was relatively detailed (Table 4.13).

Land use and zoning policies are important urban planning tools as they guide planners in addressing priority challenges posed by urbanization (Grover, 2010). These policies also have a wide-ranging, long-term and underlying impact on other sectoral policies (transport and energy, waste and water services, natural resource management) which address climate change and variability. In Nairobi, land use and zoning policies can help in addressing the challenges posed by rapid population growth, LULC modifications, and the proliferation of slums, traffic congestion and unregulated growth (Thuo, 2010). For instance, planning policy to promote sustainable land use which was well detailed by 66.7% of the policy documents could be used to control LULC modification and as a result, improve Nairobi's resilience to climate change.

Mixed land use development policies which was detailed by 66.7% of policy documents that addressed it could be used to address challenges such as population growth and traffic congestion in Nairobi city and long serve as climate change mitigation strategy by reducing the distance required to travel from one point to another or even the need to use private cars. Challenges related to the proliferation of slums can be addressed by policies promoting local development plans and strategies encouraging future development which were addressed by 26.6% of the policy document. In the long term, these policies will help in reducing climate change risks and vulnerability such as the death of people as a result of floods and water-borne diseases.

4.2.2 Urban planning and designs policies

Table 4. 14: Urban planning and design policies

Planning Practice	Policy Coverage Assessment			Policy Quality Assessment			
	Policy Addressed			Not Detailed		Detailed	
	No	Yes (a)	Coverage	N	% (a)	N	% of (a)
High density development	11	4	26.6	1	33.33	3	66.67
Promote low-water intensive landscape	15	0	0	0	0	0	0
Building height/orientation guidelines/Street-width to building height ratio	14	1	6.67	1	100	0	0
Action for urban forestry, agriculture and green areas	13	2	13.3	0	0	2	100
Land subdivision regulations	13	2	13.3	0	0	2	100
Site plan review requiring land suitability/ Impact Assessment and Special study	10	5	33.3	2	40	3	60
Development of sewage and drainage systems to control flooding	10	5	33.3	3	60	2	20
Promoting non-motorized means of travel	12	3	20	0	0	3	100
Encouraging extensive mass transit/BRT corridors and light trails	11	4	26.6	0	0	4	100

Urban designs planning policies and practices encouraging the development of extensive mass transit/BRT corridors (26.6% & 100%) and high-density development (26.6% and 66.7%) well covered and detailed by different policy documents respectively. Promotion of non-motorized means of travel had a relative coverage of 20% and 100% detailed by the policy documents addressing it. Site planning practices encouraging site plan review before development and development of drainage and sewage channels had a relative coverage of 33.33% and 60% and 20% detailed respectively by the policy documents that

had addressed them. Streamline building heights/street-width to building ratio had a relative coverage of 6.67% although it was poorly detailed as no single policy had described it. Lastly, promotion of low-water intensive landscapes was not addressed by any single policy document (Table 4.14).

Site planning and urban design policies can help developing local development plans which are responsive to immediate climate change impacts for different cities (Grover, 2010). These policies can address Nairobi's challenges such as rapid population growth, the proliferation of slums, unregulated growth, LUCC modification, traffic jam, and GHGs emission and in long-term improve the resilience of the city. For example, high-density development which was well detailed by 66.67% of the policies can help in developing high residential areas and thus accommodate more people and reduce proliferation of slums. This will also reduce climate change risk exposure to these people living in various slums in the city.

Encouraging use of non –motorized means of travel and use of mass transit which were very detailed by 100% of the policies which had addressed them could help in reducing the need to use private and in long-term help in reducing vehicular emission from the city. Promoting urban forestry can help in the management of UHI and temperature in and around Nairobi city as demonstrated by the city of Curitiba which is one of the greenest cities in the world. Though poorly addressed by the sampled policies, streamlining building height and street width can also help in the management of UHI for Nairobi as demonstrated by cities like Stuttgart, Freiburg, and Mannheim in Germany which have set minimum standards for open spaces and green corridors (OECD, 2010).

4.2.3 Building design policies

Planning practices to promote water harvesting was addressed by the majority of the policies with a relative coverage of 46.7% and well detailed by 71.4% of the policy documents that had addressed it (Table 4.15). Promoting adaptation to flooding and extreme storm events as well as evaluation of the building and infrastructural vulnerability

to withstand climate impacts had a relative coverage of 20% and detailed excellently by 100% of policy documents that had addressed them. Approval of development plans to adhere to required environmental standards had relative coverage of 13.3% but was excellently detailed by 100% of policy documents that had addressed it. Construction of porous car parks, walkways to manage surface runoff and increased building energy efficiencies was the least addressed with relative coverage of 6.7% and; 0% and 100% detailed respectively. Site planning and urban design policies evaluation protocol included ten planning policies (Table 4.15)

Table 4. 15: Building design policies

Planning Practice	Policy Coverage Assessment			Policy Quality Assessment			
	Policy Addressed		Coverage (%)	Not Detailed		Detailed	
	No	Yes (a)		N	% (a)	N	% (a)
Approval of development plans to adhere to required environmental standards	13	2	13.3	0	0	2	100
Construction of pervious car parks and walkways to reduce surface runoff	14	1	6.7	1	100	0	0
Developments of buildings with green roofs and walls to increase green masses in cities	14	2	13.3	1	50	1	50
Adaption to flooding and extreme storm events by setting minimum ground clearance for buildings	12	3	20	0	0	3	100
Evaluation of building and infrastructural vulnerability to withstand climate impacts	12	3	20	0	0	3	100
Building codes to include climate resilience.	12	3	20	1	33.33	2	66.67
Water harvesting for storage	8	7	46.7	2	28.6	5	71.4
Increased building energy efficiencies through design placement, construction materials and retrofitting with energy saving equipment	14	1	6.7	0	0	1	100

Building policies can play a significant role in improving adaptation and mitigation capacity of Nairobi city to climate change impacts. Though these policies were poorly addressed by the sampled policy documents, the few reports that had discussed them were very detailed. Promoting building energy efficiencies and technologies can significantly reduce energy demands for Nairobi city and in long-term reduce GHGs emission. These policies have been effective in Germany where the government requires new constructions for commercial buildings to achieve a minimum performance of 110 kWh/ M^2 (OECD, 2010).

Cities like Shenzhen, China, and the city of Toronto have also pioneered policies that seek to energy efficient technologies. In particular, the city of Toronto provided technical support to homeowners of large facilities to retrofit their building with energy efficiencies by establishing good partnerships and availing sustainable energy funds for them. Whereas, the City of Berlin the city project manages retrofit for both public and private building by contracting energy service companies to ensure implementation of retrofit to attain an average of 26% reduction of CO_2 (OECD,2010). Building codes requiring the construction of green roofs, clearance height to preventing flooding, water harvesting, and construction of pervious parks could improve adaptation capacity for Nairobi city by reducing Urban Heat Island (UHI), flood risks such spread of water-borne diseases as well as mortality rate

4.3 Relationship between land use policy change and land use/cover change in Nairobi city

4.3.1 Land use/cover change process in Nairobi between 1976 and 2000

4.3.1.1 Case study 1

The area coverage and percentile distribution are shown in Table 4.16 whereas percentage change and rate of change are shown in Table 4.17. The areas covered by the savanna vegetation was the most dominant covering about 70% of the total study area (Figure 4.4). Between 1976 and 2000, a 24 years period, the highest percentage decline was riverine (67%), forests and woods (61.2%), water (44.1%) and agriculture (24.9%) whereas barren surfaces and urban built-up areas showed the highest percentage increase (Table 4.17).

Bosco *et al.* (2011) observe that the increase in savannah vegetation cover could be attributed to increase in open grassland areas such as estate parks and sports fields following tree clearing as well as the conversion of land covers occupied by water. Conversion of urban area, barren surfaces, and savannah vegetation was highest between 1995 and 2000 compared to 1976 and 1995 increasing by 97%, 31%, and 4% respectively (Table 4.17). The decline in agricultural areas (1976 to 1995) and their subsequent increase (1995 to 200) is attributed to active home farming activities such as home gardens that are common in the peri-urban areas especially in riverine areas of the city (Bosco *et al.,* 2011).

Table 4. 16: Area coverage and percentage distribution of land use/cover types in Nairobi for the years 1976, 1995 and 2000

Land cover type	Year					
	1976		1995		2000	
	Km^2	%	Km^2	%	Km^2	%
Water	14	0.8	4	0.2	8	0.5
Agriculture	141	8.0	88	5.0	106	6.0
Urban	39	2.2	40	2.2	78	4.4
Forest and Wood	270	15.2	208	11.8	105	5.9
Savannah Vegetation	1186	67.0	1254	70.8	1309	73.9
Riverine	90	5.1	74	4.2	30	1.7
Barren Surface	31	1.7	104	5.9	136	7.7

Table 4. 17: Percentage change and rate of change of land use/land cover types for Nairobi City for the three-time intervals

Land cover type	Period					
	1976-1995		1995-2000		1976-2000	
	% change	Rate (km^2/yr.)	% change	Rate (km^2/yr.)	% change	Rate (km^2/yr.)
Water	-70.7	-0.54	90.8	0.77	-44.1	-1.28
Agriculture	-37.5	-2.79	20.3	3.58	-24.9	-7.02
Urban	0.5	0.01	97.6	7.72	98.5	7.75
Forest and Wood	-22.8	-3.23	-49.8	-20.75	-61.2	33.03
Savannah Vegetation	5.7	3.55	4.4	11.02	10.3	24.51
Riverine	-18.0	-0.85	-59.8	-8.81	-67.1	-12.04
Barren Surface	237.3	3.85	31.2	6.48	342.5	21.10

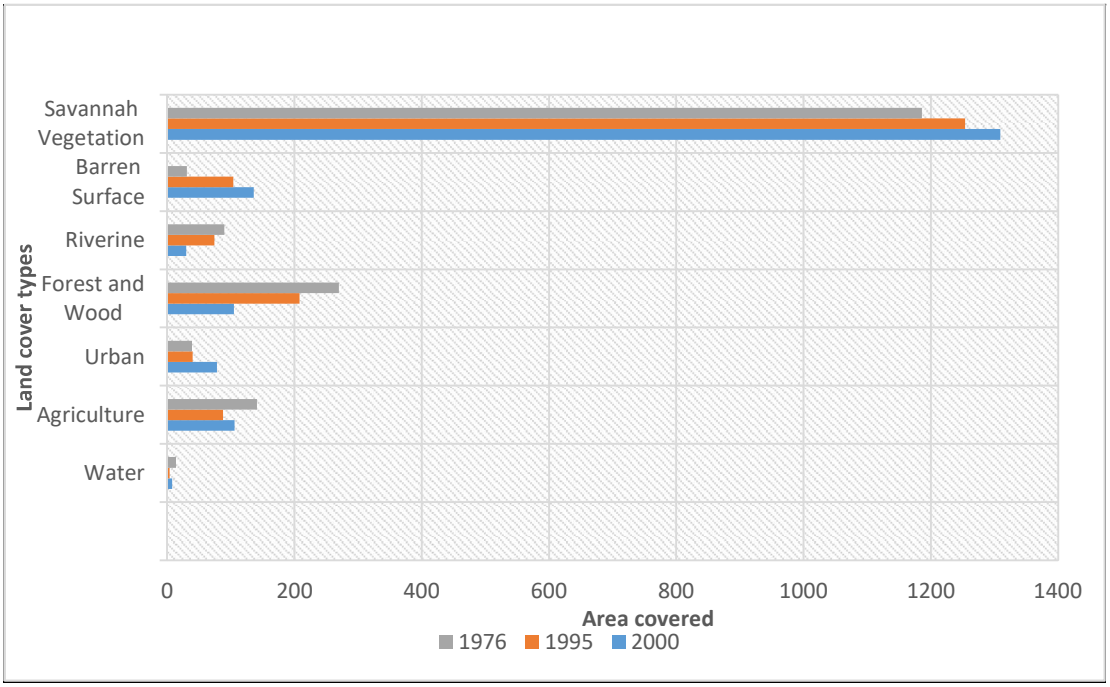

Figure 2.1: Land use/cover change pattern from 1976 to 2000

4.3.1.2 Case study 2

The area covered by the urban/built-up areas increased from 13.99 km^2 in 1976 to 41.18 km^2 in 1995 to 61.23 km^2 in 2000 (Table 4.18). Agricultural land increased from 49 km^2 in 1976 to 88 km^2 in 2000. Forest cover decreased from 100km^2 in 1976 to 23km^2 in 2000 a total loss of about 77km^2 (Table 4.18). Between 1976 and 2000, a 24 years period, the highest percentage decline was forests (76.48%), bushland (37.87%) and mixed rangeland (33.50%) whereas shrubs/brush range, open/transitional and urban/built areas increased substantially (Table 4.18 and Figure 4.2). Mundia and Aniya (2006) attributed the loss of rangeland (mixed rangeland and shrub/brush) to urban sprawl and the expansion of agriculture.

Spatial urban sprawl patterns show a variation in the direction in different times of the study which Mundi and Aniya (2006) attributed to some factors including nature of planning, change of land use zoning regulations over time and land speculation. The growth of the city indicated a star-shaped urban sprawl with urban development taking place along the main transport routes emanating from the city center. The rate of urban

encroachment on other land cover types has been significant (Table 4.19) with forests, agricultural land and rangeland being converted to build up areas. The increase in agriculture from 49km^2 in 1976 to 88km^2 in 2000 was attributed to population increase that led to increased demand for food hence intensification of peri-urban agriculture (Mundia and Aniya 2006).

Table 4. 18: Areas of land use/cover types for Nairobi city extracted from Landsat images

Land use/cover class	Year					
	1976		1988		2000	
	Km^2	%	Km^2	%	Km^2	%
Urban areas	13.99	1.90	41.18	5.77	61.23	8.58
Agriculture	49.83	6.98	57.83	8.10	87.78	12.30
Forests	100.15	14.04	29.09	4.08	23.56	3.30
Bushlands	154.48	22.35	101.49	14.22	95.98	13.45
Mixed rangeland	357.32	50.08	340.62	47.74	237.63	33.31
Shrub/brush range	25.22	3.53	64.19	8.99	170.78	23.94
Open/Transitional	6.92	0.96	77.96	10.92	32.72	4.58
Water	0.50	0.07	1.09	0.15	3.77	0.53
Total	**713.41**	**100**	**713.41**	**100**	**713.41**	**100**

Table 4. 19: Percentage change and rate of change of land use/land cover types for Nairobi City for the three-time intervals

Land cover type	Period					
	1976-1988		1988-2000		1976-2000	
	% change	Rate (km^2/yr.)	% change	Rate (km^2/yr.)	% change	Rate (km^2/yr.)
Urban areas	194.35	2.27	48.69	1.67	337.67	1.97
Agriculture	16.05	0.67	51.79	2.50	76.16	1.58
Forests	-70.95	-5.92	-19.01	-0.46	-76.48	-3.19
Bushlands	-34.30	-4.41	-5.43	-0.45	-37.87	-2.43
Mixed rangeland	-4.67	-1.39	-30.24	-8.58	-33.50	-4.99
Shrub/brush range	154.52	3.24	166.05	8.88	577.16	6.07
Open/Transitional	1026.59	5.92	-58.03	-3.77	372.83	1.08
Water	118	0.05	245.87	0.22	654	0.14

Table 4. 20: Major Land use/cover conversion from 1976 to 2000

"From class."	"To class."	1976-1988 Area (Km^2)	1988-2000 Area (Km^2)
Forest	Urban	4.03	2.75
	Agriculture	12.99	4.99
	Open/transitional	13.95	1.02
	Bushland	13.38	10.06
Mixed rangeland	Urban	22.00	29.61
	Agriculture	10.90	22.01
	Bushland	12.98	16.48
	Open/transitional	27.95	16.67
Bushland	Urban	8.40	3.65
	Agriculture	24.20	21.53
Open/transitional	Urban	4.38	8.56
	Agriculture	6.34	19.34
Shrub/bush range	Urban	8.61	11.27
	Agriculture	7.90	10.38
Agriculture	Urban	2.07	3.76

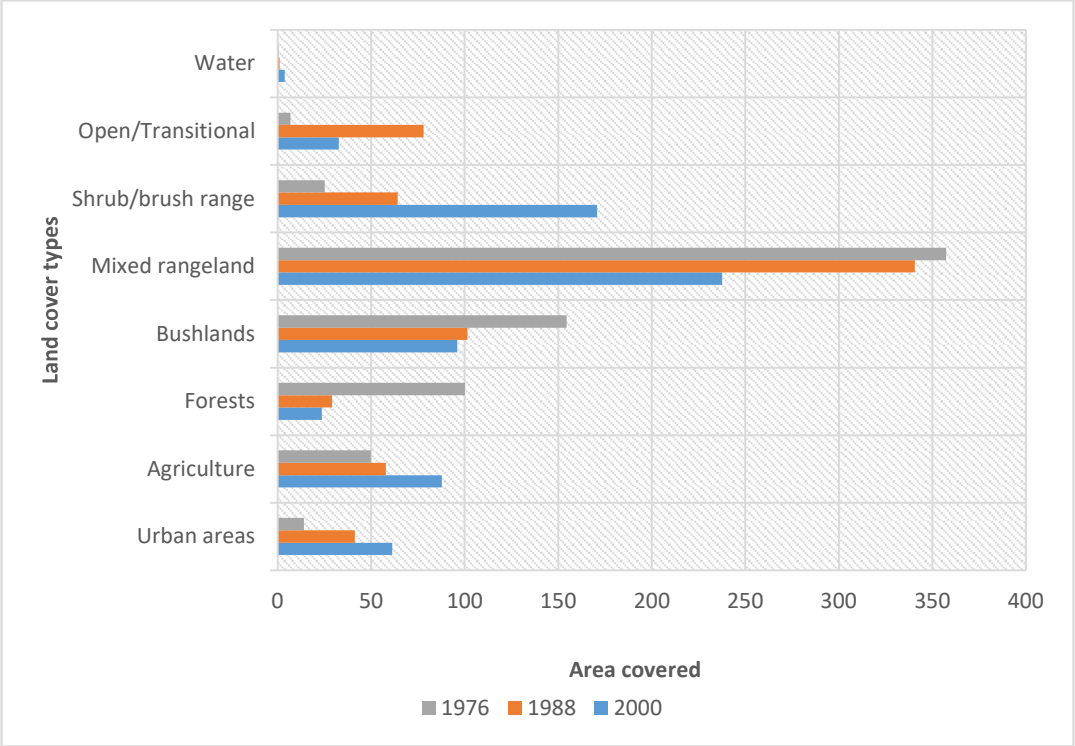

Figure 4. 2: Land use/cover change trend between 1976 and 2000

4.3.2 Influence of land use policy on land use/cover processes from 1976 to 2000

The city of Nairobi experienced significant land use/cover conversion from 1976 to 2000 which were majorly characterized by a substantial increase in urban built-up areas and barren surfaces as well as a decline in forests, bushland, riverine, water and mixed loss and gain for agriculture cover. By relating these land use/cover processes, it can be found that land use policy has had a profound influence on LUCC from 1976 to 2000. Most of the policies covering this period were an extension of the colonial policies that had evolved to advance the self-rule from colonial administration. Within this period, urban built-up areas increased significantly whereas forests, riverine, rangeland, and agriculture decreased significantly.

These LUCC processes could be attributed to land use planning policies as they did not spell out how urban planning and development was supposed to take place as well as the

contents of the new town plans (Table 4.21). A report by Enemark *et al*. (2009) indicated that Land Planning Act of 1968 failed because it did not seek the support of the locals as it bestowed plan formulation responsibility to the central government whereas implementation responsibility was given to the local government resulting to development plans that were not informed by immediate local needs.

Between 1995 and 2000 the urban built-up area continued to increase but at a slower rate of 24% from 70.17%, agriculture and water increased by 20.8% and 90.8% respectively while forests, riverine and rangeland continued to decrease. The change in land use/cover pattern could be attributed to the Physical Planning Act, 1996 which conferred powers to the local authorities to control development by approving new developments as well as regulation land subdivision. However, the Act remained silent on specific areas which development was to be prohibited the reason which could be attributed to the continued loss of areas covered by forests, riverine and rangeland between 1995 and 2000. Although forestry policies during this time promoted the protection of forest reserves from destruction, their efficacy was not significant because forests and other sensitive areas continued to decline (Figure 4.2).

These policies also failed to encourage reforestation programs that were key in recovering tree cover that had been lost during the colonial times. Their ineffectiveness could also be attributed to conflicting policies such as the National Food Security of 1981. The policy encouraged conversion of forests covers to promote food security, population growth leading to accelerated urbanization to meet the housing demand, rapid economic growth (from a GDP of $254 million in 1975 to $1.5 million in 2002) resulting to expansion of urban built-up areas as well as political influence that majorly characterized by land grabbing and corruption. Lastly, the agricultural policies were remarkably silent on peri-urban and urban agriculture but instead focused on resettlement schemes, the growth of the agricultural sector in the rural areas and privatization of state-owned corporation to encourage private investment in agriculture. The decline in agriculture cover between 1976 and 1995 could also be attributed to population growth that led to the conversion of productive agricultural lands in the peri-urban areas to build forms (Figure 4.2)

Table 4. 21: A summary of land use policies and their implication on land use/cover processes in Nairobi city from 1976 and 2000

Regime	Policies	Major land use policy actions and interventions	Major LUCC processes
1976 to 2000	Land planning Act, 1968 Metropolitan Growth Strategy, 1973 Human Settlement Strategy1978 1984-1988 Nairobi city commission development plan Agriculture Act 1980, Cap 318 National food policy, 1981 Structural Adjustment Programmes (SAPs 1994) Forestry Policy of 1968 Forestry Policy of 1962 5th Development Plan 1984-89 6th Development Plan 1989-93 Physical Planning Act of 1996 Forestry Policy of 1962 Agriculture Act 1980, Cap 318 National food policy, 1981	Encouraged control of urban development by providing guidelines for making town plans to manage future urban growth Promoted extension of Nairobi to the west and northeast and development of satellite towns (Thika, Machakos and Athi River). Promoted formulation of national, regional and local physical planning guidelines and policies. Conferred powers to the local authorities to control land subdivision, approve development, regulate land use zoning and maintain green spaces. Encouraged local authorities to oversee physical planning and development of Nairobi Removed private rights from Kenyan forests Promoted protection of forests from wildfires and grazing. Conferred powers to minister in charge of forestry to create nature reserves to protect forests. Promoted management of catchment and riparian area to conserve soil Promoted change of land ownership to guide resettlement schemes Promoted liberalization of markets to encourage commercial agriculture.	Increased urban built up area. Increased barren surface Reduced forest, bushlands and riverine cover Area covered by water decreased. Agricultural cover decreased between 1976 to 1995; increased from 1995 to 2000

4.3.3 Land Use/Cover Change Process in Nairobi between 1988 and 2015

4.3.3.1 Case study 3

Urban built up; the open and transitional land cover showed a significant increase from 73.08 km^2 in 1988 to 222.65 km^2 in 2015 (Table 4.22) representing a total increase of 212.87% and about 31.11km/year change rate (Table 4.23). Agricultural, grass, riparian and vegetation cover showed a significant increase from 126.82km^2 in 1988 to 189.73 km^2 in 2015. Forests increased from 59.63km^2 in 1988 to 122 km^2 in 1995 but declined to 63.63 km^2 in 2000. Oyugi *et al.* (2017) attributed this decline to extraction and clearance of forest resources to pave the way to urban developments which increased significantly between 1995 and 2002. Forests cover increased from 63.63km^2 in 2000 to 93.44km^2 in 2015 (Table 4.22).

The area under rangeland and shrubs declined from 453.99km^2 in 1988 to 200.30km^2 in 2015. Oyugi *et al*. (2017) attribute the decrease in agricultural, grass, secondary growth, riparian, rangeland, forests, and shrubs covers to the expansion of built-up areas, open and transitional areas or urban sprawl (Table 4.22). Development of the city was relatively faster along major roads leading to the city such as Thika road, Mombasa road, and Kangundo road. According to Oyugi *et al*. (2017), the nature of planning was occasioned by rapid revision of land use zoning policies (minimum plot size, plot ratios, and coverage), land speculation and land cover changes.

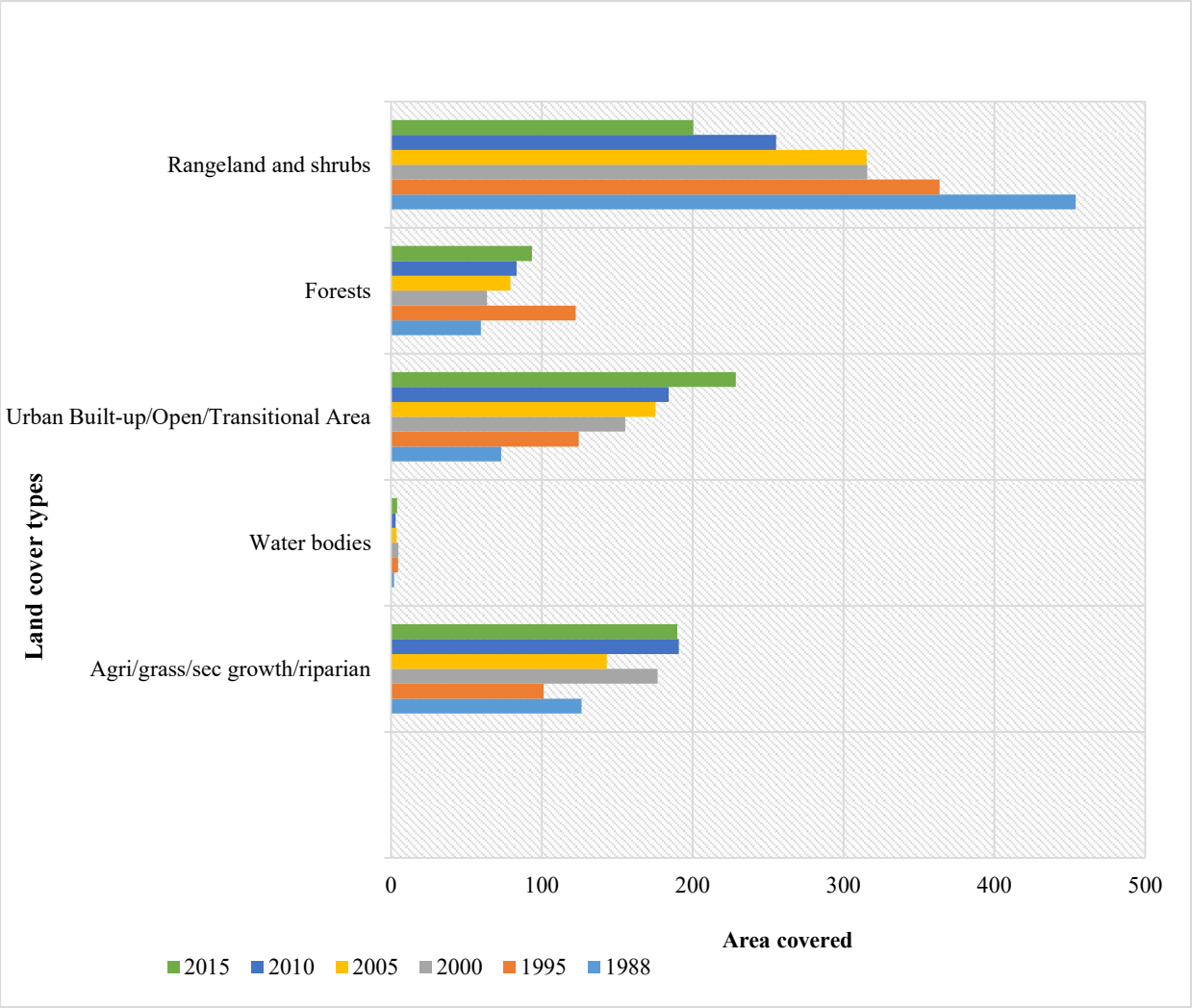

Figure 4.3: Land use/cover change pattern from 1988 to 2015

Table 4. 22: Land Use and Land Cover Types in Nairobi City between the Years 1988 to 2015

Land Use and Land Cover Classes	Year											
	1988		1995		2000		2005		2010		2015	
	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%
Agriculture/Grass/Secondary growth/Riparian vegetation	126.28	17.71	101.12	14.12	176.76	24.68	143.03	19.97	190.75	26.63	189.73	26.49
Water bodies	2.07	0.38	4.72	0.66	4.84	0.68	3.62	0.51	3.04	0.42	4.09	0.57
Urban Built-up/Open/Transitional Area	73.08	10.20	124.36	17.36	155.2	21.67	175.19	24.46	183.97	25.69	228.65	31.93
Forests	59.63	8.33	122.41	17.09	63.63	8.88	79.14	11.05	83.19	11.62	93.44	13.05
Rangeland and shrubs	453.99	63.39	363.61	50.77	315.79	44.09	315.23	44.01	255.25	35.64	200.30	27.97
Total	**716.22**	**100.00**	**716.22**	**100.00**	**716.22**	**100.00**	**716.22**	**716.22**	**716.22**	**100.00**	**716.22**	**100.00**

Table 4. 23: Percentage change and rate of change of land use/land cover types for Nairobi City for the six-time interval

Land Use and Land Cover Classes	Period											
	1988/1995		1995/2000		2000/2005		2005/2010		2010/2015		1988/2015	
	%change	Rate (Km2/yr.)	%change	Rate (Km2/yr.)	%change	Rate (Km2/yr.)	%change	Rate (Km2/yr.)	%change	Rate (Km2/yr.)	%change	Rate (Km2/yr.)
Agriculture/Grass/Secondary growth/Riparian vegetation	-19.92	-3.59	74.80	15.13	-19.08	-6.75	33.36	9.54	-0.03	-0.20	50.25	12.69
Water bodies	128.02	0.38	2.54	0.02	-25.21	-0.24	-16.02	-0.12	1.73	0.21	97.58	0.40
Urban Built-up/Open/Transitional Area	70.17	7.33	24.80	6.17	12.88	4.00	5.01	1.76	1.21	8.94	212.87	31.11
Forests	105.28	8.97	-48.02	-11.76	24.38	3.10	5.11	0.81	0.62	2.05	56.70	6.76
Rangeland and shrubs	-19.90	-12.91	-13.15	-9.56	-0.18	-0.11	19.02	-12.00	-1.08	-10.99	-55.88	-50.74

Table 4. 24: Major Land Use and Cover Changes in Nairobi for Different Epochs

From class	To class	1988-1995		1995-2000		2000-2005		2005-2010		2010-2015	
		Area (Km^2)	Percent	Area (Km^2)	Percent	Area (Km^2)	Percent	Area (Km^2)	Percent	Area (Km^2)	Percent
Agricultural/grass/ Secondary growth/riparian vegetation	Forest	54.11	7.56	1.84	0.26	22.10	3.09	18.75	2.62	31.55	4.41
	Rangeland and shrubs	38.46	5.37	62.39	8.71	35.06	4.90	20.04	2.80	28.46	3.97
	Urban built-up/open/transitional	9.26	1.29	16.48	2.30	17.27	2.41	11.72	1.64	12.34	1.72
	Water bodies	0.24	0.03	0.22	0.03	0.19	0.03	0.08	0.01	0.66	0.09
Forests	Agricultural/grass/ Secondary growth/riparian vegetation	2.28	0.32	60.62	8.46	7.64	1.07	16.50	2.30	20.03	2.80
	Rangeland and shrubs	5.29	0.74	4.66	0.65	0.71	0.10	0.75	0.11	1.10	0.15
	Urban built-up/open/transitional	2.57	0.36	1.27	0.18	1.88	0.26	0.90	0.13	1.28	0.18
	Water bodies	0.19	0.03	0.71	0.10	0.13	0.02	0.09	0.01	0.17	0.02
Rangeland and shrubs	Agricultural/grass/ Secondary growth/riparian vegetation	73.38	10.25	78.35	10.94	30.36	4.24	56.93	7.95	39.19	5.47
	Forests	17.19	2.40	5.12	0.71	0.48	0.05	1.36	0.19	0.19	0.03
	Urban built-up/open/transitional	60.72	8.48	65.30	9.12	73.23	10.22	56.75	7.92	97.67	13.64
	Water bodies	2.30	0.32	0.44	0.06	0.06	0.01	0.09	0.01	0.22	0.07
Urban built-up/open/transitional	Agricultural/grass/ Secondary growth/riparian vegetation	2.77	0.39	16.09	2.25	6.76	0.94	23.86	3.33	11.27	1.57
	Forests	0.79	0.11	1.74	0.24	0.14	0.02	1.59	0.22	1.22	0.17
	Rangeland and shrubs	17.51	2.44	34.70	4.84	44.83	6.26	58.35	8.15	53.78	7.51
	Water bodies	0.02	0.00	0.29	0.04	0.00	0.00	0.27	0.04	0.51	0.07
Water bodies	Forests	0.12	0.02	0.08	0.01	0.62	0.09	0.20	0.03	0.00	0.00
	Agricultural/grass/ Secondary growth/riparian vegetation	0.15	0.02	0.88	0.12	0.28	0.04	0.41	0.06	0.32	0.04
	Rangeland and shrubs	0.22	0.03	0.29	0.04	0.35	0.05	0.11	0.01	0.12	0.02
	Urban built-up/open/transitional	0.22	0.03	0.08	0.01	0.41	0.06	0.19	0.03	0.22	0.03
No change		428.43	59.82	364.66	50.92	473.69	66.14	447.28	62.45	415.94	58.07

4.3.4 Influence of land use policies on the land cover change between 2000 and 2015

The period between 2000 and 2015 was marked with significant land use policy shifts in Kenya. The shift was primarily influenced by the entry of a new political dispensation in 2002 and the call by different actors to promote environmental sustainability in Nairobi. The first achievement was marked by the enactment of the Environmental Management Coordination Act (EMCA) of 1999 and subsequent establishment of National Environmental Management Authority (NEMA) to ensure compliance with different environmental policies along with National Environmental Council (NEC) to develop more policies in relation to environmental protection and sustainable development in Kenya.

By relating these policies with land use processes in Nairobi, it can be found that the policies have played a profound role in directing land use patterns in the city. Firstly, the NARC government in 2003 promoted strategies that sought to re-emphasize and re-energize the need to increase tree cover in Kenya. These strategies included degazettement and clearance of illegal structures in the forest reserves which could be attributed to the sudden increase of forest areas from 2000 to 2015 (Table 4.22; figure 4.3). The sustained growth in areas covered by forest and riverine can be attributed to subsequent forestry and environmental policies. These policies strengthened the call to protect all sensitive areas from encroachment as well as the establishment of NEMA. It was mandated to keep the inventory of all national natural resources, license any development project before commencement (EIA license), and enforce compliance to different environmental policies including charging offenders in the court of law as well as increased awareness among the member of the public on the importance of ecological conservation.

The mixed gain and losses for areas covered by agriculture (Figure 4.3) can be attributed to the different agricultural policies (Table 4.22) that have not directly addressed peri-urban and urban agriculture but instead focused on promoting large scale and commercial farming in rural areas where agriculture is largely practiced with the aim of improving food security and driving economic growth of Kenya. Additionally, the decline in the area covered by agriculture is attributed to population growth in the city which has resulted to more land fragmentation and conversion of agriculturally productive lands in peri-urban areas to high-density residential areas (Oyugi *et al.,* 2017). Land use planning policies which currently have a strong bearing on the National Constitution (Chapter 5) and the National Land Policy provide a strong anchorage for the different forestry and environmental protection policies that seek to promote sustainable development of Nairobi through proper urban planning and development

Table 4. 25: A summary of land use policies and their implication on land use/cover processes in Nairobi city between 2000 and 2015

Regime	Policies	Policy actions and interventions	Major LUCC processes
2000-2015	Environmental Coordination Management Act of 1999 National Poverty Reduction Strategy, 2001 Strategy to Revitalize Agriculture (SRA, 2004 to 2014) National Environment Policy Economic recovery strategy for wealth creation Forestry Policy 2005 Government Land Act Physical planning handbook 2007 Vision 2030 National land policy 2009 Agriculture Sector Development Strategy (ADS, 2010-2020) National Climate Change Response Strategy 2010 National Climate Change Action Plan 2013-2017 National Adaptation Plan 2015-2030	Promoted environmental conservation and management Promoted protection of sensitive areas such as riverine, forests, green spaces and wetlands Promoted sustainable land use planning and development Promoted Impact Assessment on projects likely to negatively impact the environment Promoted agriculture as an economic engine to the economic growth of the country Promoted tree planting to achieve 10% tree cover Encourage recovery of public land Promoted community involvement in forest management Promoted afforestation and reforestation programs	Built-up areas/open/transitional areas increased Shrubs/rangeland/forests increased Agricultural/secondary growth/riparian area increased Water bodies showed mixed gains and losses

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Conclusions

As the population of Nairobi city increase, demand for essential services such as low-income housing to provide shelter, transport system, water, drainage and sewer lines, and waste management systems among others will continually increase. If the current development trend in Nairobi continues in the same path, the city's infrastructure will fall woefully short of what is necessary to sustain the lives of its inhabitant as well as cushion them from ravages associated with climate change and variability. In respect to the increasing demand to address current urban planning challenges currently facing Nairobi city as described in this study. The customary models of planning and use of planning policies, community perception and mitigation preferences, relationship between land use policy and land use/cover factors have to been critically reviewed to enable development of other integrated approaches that place climate change at their heart to guide future development of a resilient city.

5.1.1 Perception and mitigation preferences for climate change management strategies

The result of this study is an accurate reflection of resident perception on various issues related to climate change and policies including public awareness and understanding, perception on causes and effects, concern and their preference on management policies related to climate change in cities. Majority of the respondents had heard about climate change in the past though most of them were only familiar climate change issues directly linked with environmental issue such as change of rain pattern and extended dry periods. These climate variability aspects were perceived as significant signs of climate change while water scarcity and spread of infectious diseases such as cholera were perceived as major effects of climate change. However, there was a knowledge gap to complicated issues related to climate change. Residents also expressed significant levels of worry and

concern about climate change thus reflecting their likelihood to take individual responsibility towards taking necessary actions towards management climate change. This was attested by their aggregate mean score of 4.37 preference to different strategies that if embraced could help to manage climate change perceived effects in Nairobi. Educational status emerged as a top social demographic attribute that influenced respondents' level of awareness, knowledge, worry, and concern towards climate change.

7.1.2 Review of existing policies in relation to climate change management

Urban planning and building design policies can be useful tools for addressing the immediate challenges, climate change risks and vulnerabilities experienced in Nairobi city. The study found that different planning components were addressed by different policy documents reviewed. Even though the relative coverage rate was low, most of them had a high-quality index as they had detailed various climate management practices to satisfaction. Although the city continues to suffer from environmental quality, unregulated land use conversion without recourse on existing laws; unapproved and poorly constructed buildings, the study finds that the existing policies can potentially address the immediate climate-related needs for Nairobi city and consequently, improve its resilience to climate change impacts.

5.1.3 Relationship between land use policy change and land use/cover change

Nairobi has undergone significant land use/cover processes from 1976 to 2015. Similarly, land use policy significantly changed thereby affecting land use/cover modification in different ways. The period between 1976 and 2000 which was characterised by the evolution of colonial policies, major land use processes included an increase in built-up areas, a decrease in forests, riverine, brushland, water and mixed gain and loss for agriculture. In the second phase, 2000 to 2015, there was a significant shift in land use policy with the new policies mainly borrowing from international policies on sustainable development, ecological and environmental conservation and management.

Policies in this regime majorly focused on sustainable land development, controlled land fragmentation, forest, wetlands and riverine conservation and management, ecological and climate change management from a perspective of urban planning. As a result, the observed increase in forests, riverine, agriculture and water areas in the city could be attributed to these policies among other factors such as government commitments, improved public awareness on environmental conservation and devolution of county governments. Therefore, it is worth noting that, land use policy change significantly influenced land use and cover change processes in Nairobi City County between 1976 and 2015.

7.3 Recommendations

1. The national government through the relevant departments and the county government of Nairobi should expand publicity on climate change to improve climate change awareness among the residents. This will improve individual willingness, actions, and support to different climate change policy framework.

2. Due to the scattered nature of reviewed policies, establish and harmonize a national legal framework for urban development to enhance sustainable development and management of climate change and variability.

3. Strengthen capacity and implementation of existing land use policies and laws to enhance sustainable urban development through control of land-use/cover processes in Nairobi City County.

5.4 Further studies

To fill the gaps of this study, future studies should:-

1. Investigate the implementation index of the existing policies and their effect on climate change management in Nairobi City County.

2. Determine the synergies and conflicts between different state organs mandated with urban planning, environmental protection and enforcement of policies.

3. Integration of climate change models (ENV Met, Rayman, Design-Builder, and MUKLIMO) in policy formulation.

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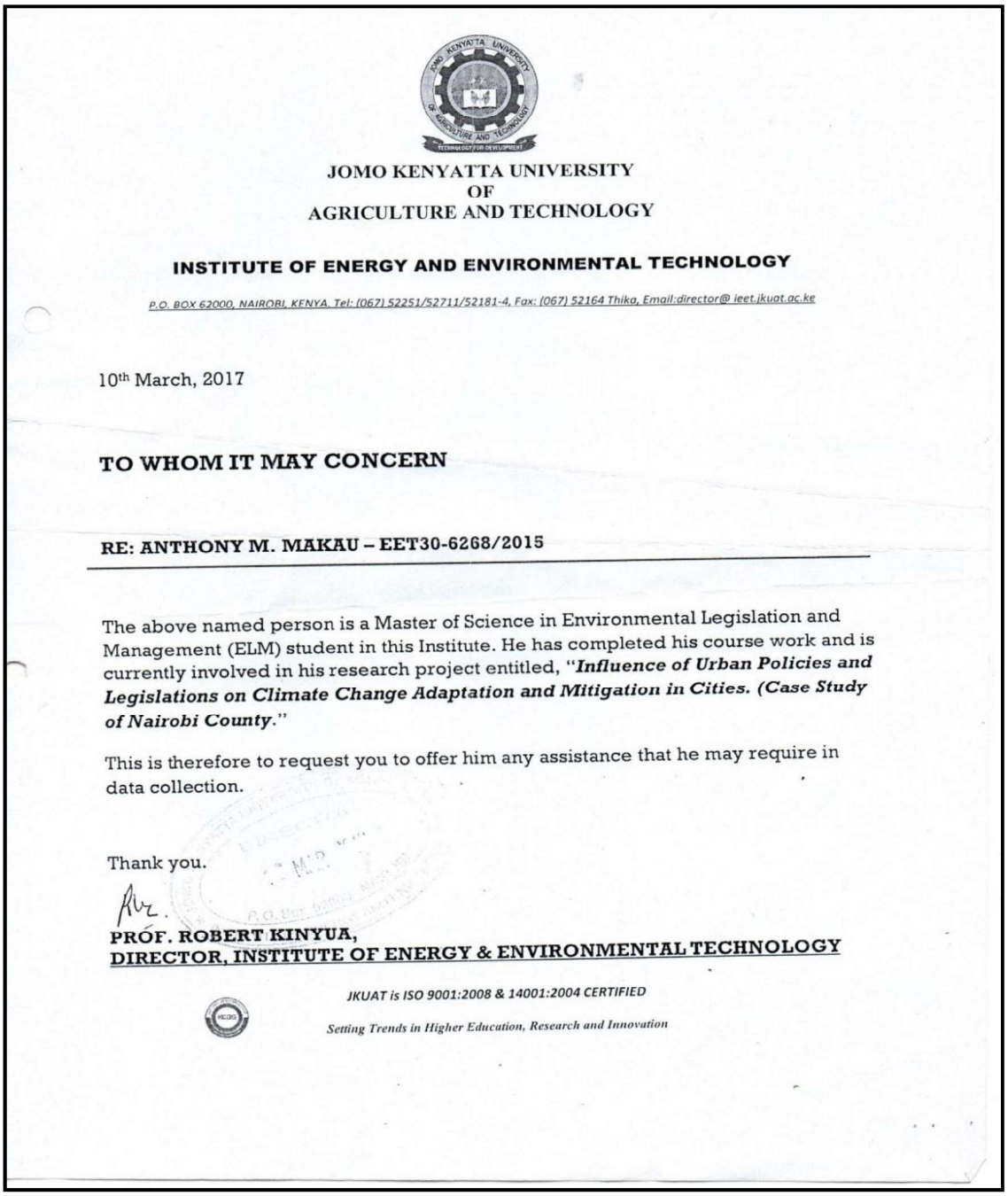
APPENDICES

Appendix I: Letter of Introduction



JOMO KENYATTA UNIVERSITY
OF
AGRICULTURE AND TECHNOLOGY

INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY

P.O. BOX 62000, NAIROBI, KENYA. Tel: (067) 52251/52711/52181-4, Fax: (067) 52164 Thika, Email:director@ ieet.jkuat.ac.ke

10th March, 2017

TO WHOM IT MAY CONCERN

RE: ANTHONY M. MAKAU – EET30-6268/2015

The above named person is a Master of Science in Environmental Legislation and Management (ELM) student in this Institute. He has completed his course work and is currently involved in his research project entitled, "***Influence of Urban Policies and Legislations on Climate Change Adaptation and Mitigation in Cities. (Case Study of Nairobi County***."

This is therefore to request you to offer him any assistance that he may require in data collection.

Thank you.

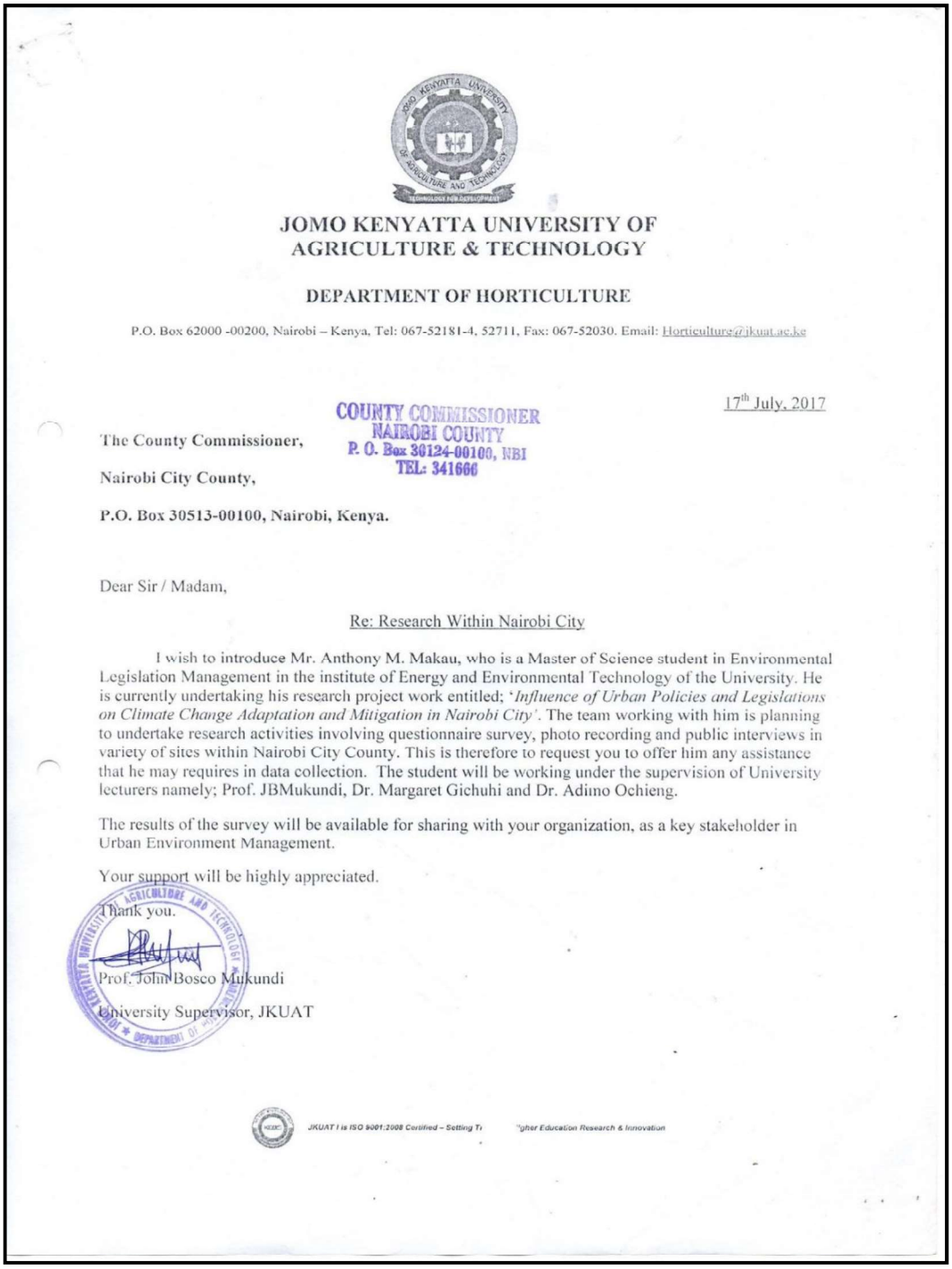
PROF. ROBERT KINYUA,
DIRECTOR, INSTITUTE OF ENERGY & ENVIRONMENTAL TECHNOLOGY

JKUAT is ISO 9001:2008 & 14001:2004 CERTIFIED

Setting Trends in Higher Education, Research and Innovation

Appendix II

County Commissioner of Nairobi Research Permit



JOMO KENYATTA UNIVERSITY OF
AGRICULTURE & TECHNOLOGY

DEPARTMENT OF HORTICULTURE

P.O. Box 62000 -00200, Nairobi – Kenya, Tel: 067-52181-4, 52711, Fax: 067-52030. Email: Horticulture@jkuat.ac.ke

17th July, 2017

COUNTY COMMISSIONER
NAIROBI COUNTY
P. O. Box 30124-00100, NBI
TEL: 341666

The County Commissioner,

Nairobi City County,

P.O. Box 30513-00100, Nairobi, Kenya.

Dear Sir / Madam,

Re: Research Within Nairobi City

I wish to introduce Mr. Anthony M. Makau, who is a Master of Science student in Environmental Legislation Management in the institute of Energy and Environmental Technology of the University. He is currently undertaking his research project work entitled; '*Influence of Urban Policies and Legislations on Climate Change Adaptation and Mitigation in Nairobi City*'. The team working with him is planning to undertake research activities involving questionnaire survey, photo recording and public interviews in variety of sites within Nairobi City County. This is therefore to request you to offer him any assistance that he may requires in data collection. The student will be working under the supervision of University lecturers namely; Prof. JBMukundi, Dr. Margaret Gichuhi and Dr. Adimo Ochieng.

The results of the survey will be available for sharing with your organization, as a key stakeholder in Urban Environment Management.

Your support will be highly appreciated.

Thank you.

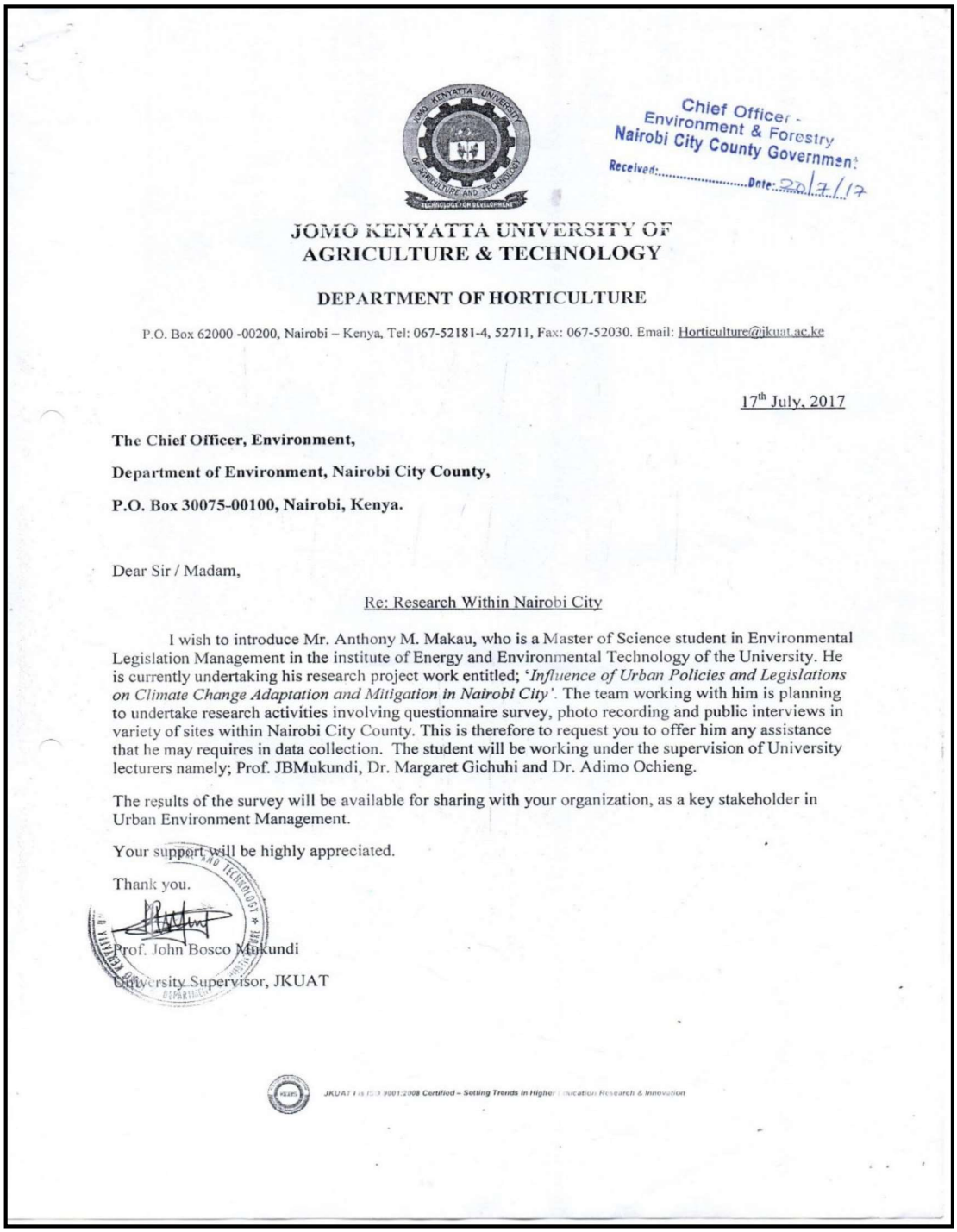
Prof. John Bosco Mukundi

University Supervisor, JKUAT

JKUAT I is ISO 9001:2008 Certified – Setting Tr "gher Education Research & Innovation

Appendix III

Department of Environment and Forestry, Nairobi County Permit



Chief Officer - Environment & Forestry
Nairobi City County Government
Received:..... Date: 20/7/17

JOMO KENYATTA UNIVERSITY OF AGRICULTURE & TECHNOLOGY

DEPARTMENT OF HORTICULTURE

P.O. Box 62000 -00200, Nairobi – Kenya, Tel: 067-52181-4, 52711, Fax: 067-52030. Email: Horticulture@jkuat.ac.ke

17th July, 2017

The Chief Officer, Environment,

Department of Environment, Nairobi City County,

P.O. Box 30075-00100, Nairobi, Kenya.

Dear Sir / Madam,

Re: Research Within Nairobi City

I wish to introduce Mr. Anthony M. Makau, who is a Master of Science student in Environmental Legislation Management in the institute of Energy and Environmental Technology of the University. He is currently undertaking his research project work entitled; '*Influence of Urban Policies and Legislations on Climate Change Adaptation and Mitigation in Nairobi City*'. The team working with him is planning to undertake research activities involving questionnaire survey, photo recording and public interviews in variety of sites within Nairobi City County. This is therefore to request you to offer him any assistance that he may requires in data collection. The student will be working under the supervision of University lecturers namely; Prof. JBMukundi, Dr. Margaret Gichuhi and Dr. Adimo Ochieng.

The results of the survey will be available for sharing with your organization, as a key stakeholder in Urban Environment Management.

Your support will be highly appreciated.

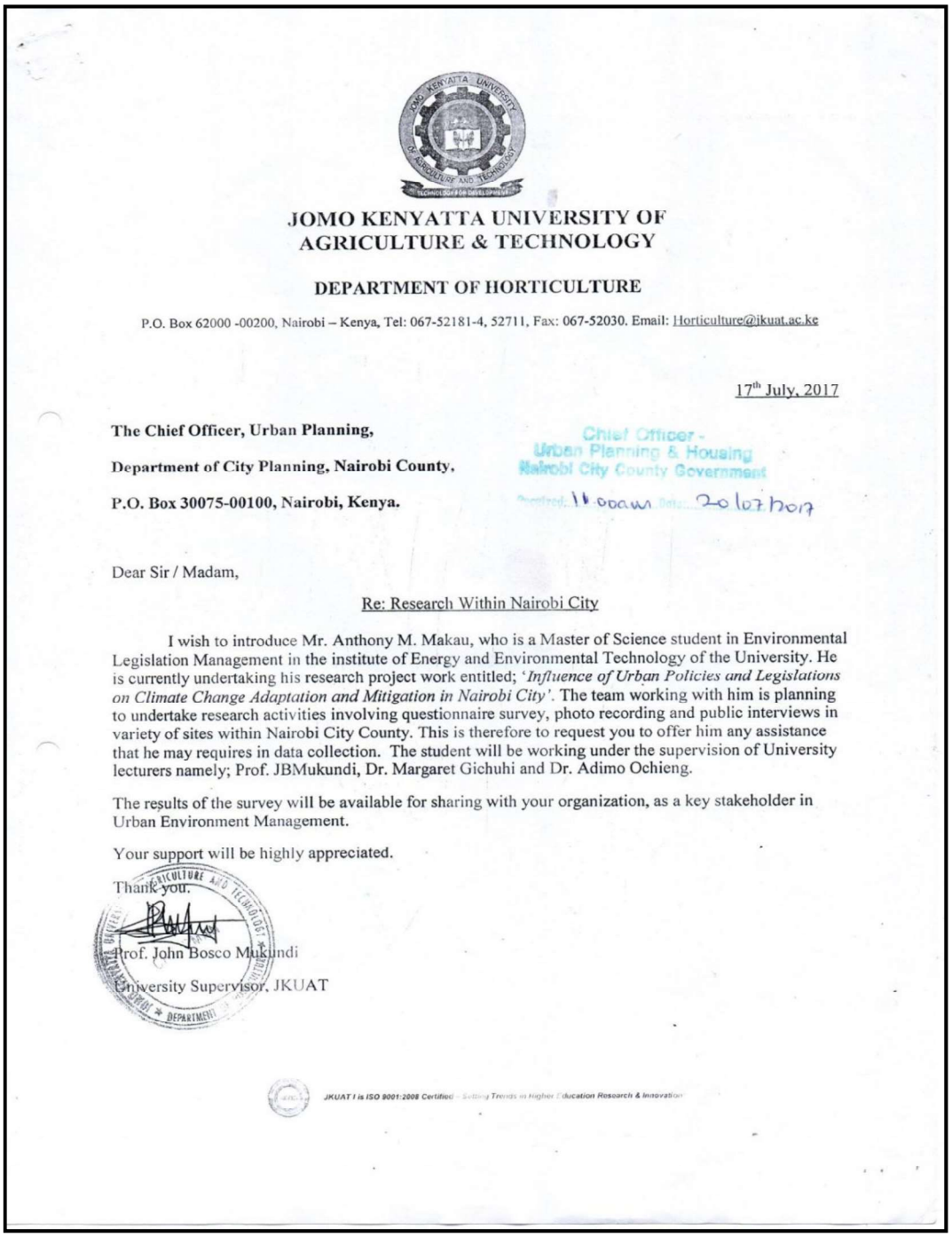
Thank you.

Prof. John Bosco Mukundi
University Supervisor, JKUAT

JKUAT ISO 9001:2008 Certified – Setting Trends in Higher Education Research & Innovation

Appendix IV

Department of Urban Planning and Housing, Nairobi County Permit



JOMO KENYATTA UNIVERSITY OF
AGRICULTURE & TECHNOLOGY

DEPARTMENT OF HORTICULTURE

P.O. Box 62000 -00200, Nairobi – Kenya, Tel: 067-52181-4, 52711, Fax: 067-52030. Email: Horticulture@jkuat.ac.ke

17th July, 2017

The Chief Officer, Urban Planning,

Department of City Planning, Nairobi County.

P.O. Box 30075-00100, Nairobi, Kenya.

Chief Officer -
Urban Planning & Housing
Nairobi City County Government
Received: [illegible] Date: 20/07/2017

Dear Sir / Madam,

Re: Research Within Nairobi City

I wish to introduce Mr. Anthony M. Makau, who is a Master of Science student in Environmental Legislation Management in the institute of Energy and Environmental Technology of the University. He is currently undertaking his research project work entitled; '*Influence of Urban Policies and Legislations on Climate Change Adaptation and Mitigation in Nairobi City*'. The team working with him is planning to undertake research activities involving questionnaire survey, photo recording and public interviews in variety of sites within Nairobi City County. This is therefore to request you to offer him any assistance that he may requires in data collection. The student will be working under the supervision of University lecturers namely; Prof. JBMukundi, Dr. Margaret Gichuhi and Dr. Adimo Ochieng.

The results of the survey will be available for sharing with your organization, as a key stakeholder in Urban Environment Management.

Your support will be highly appreciated.

Thank you.

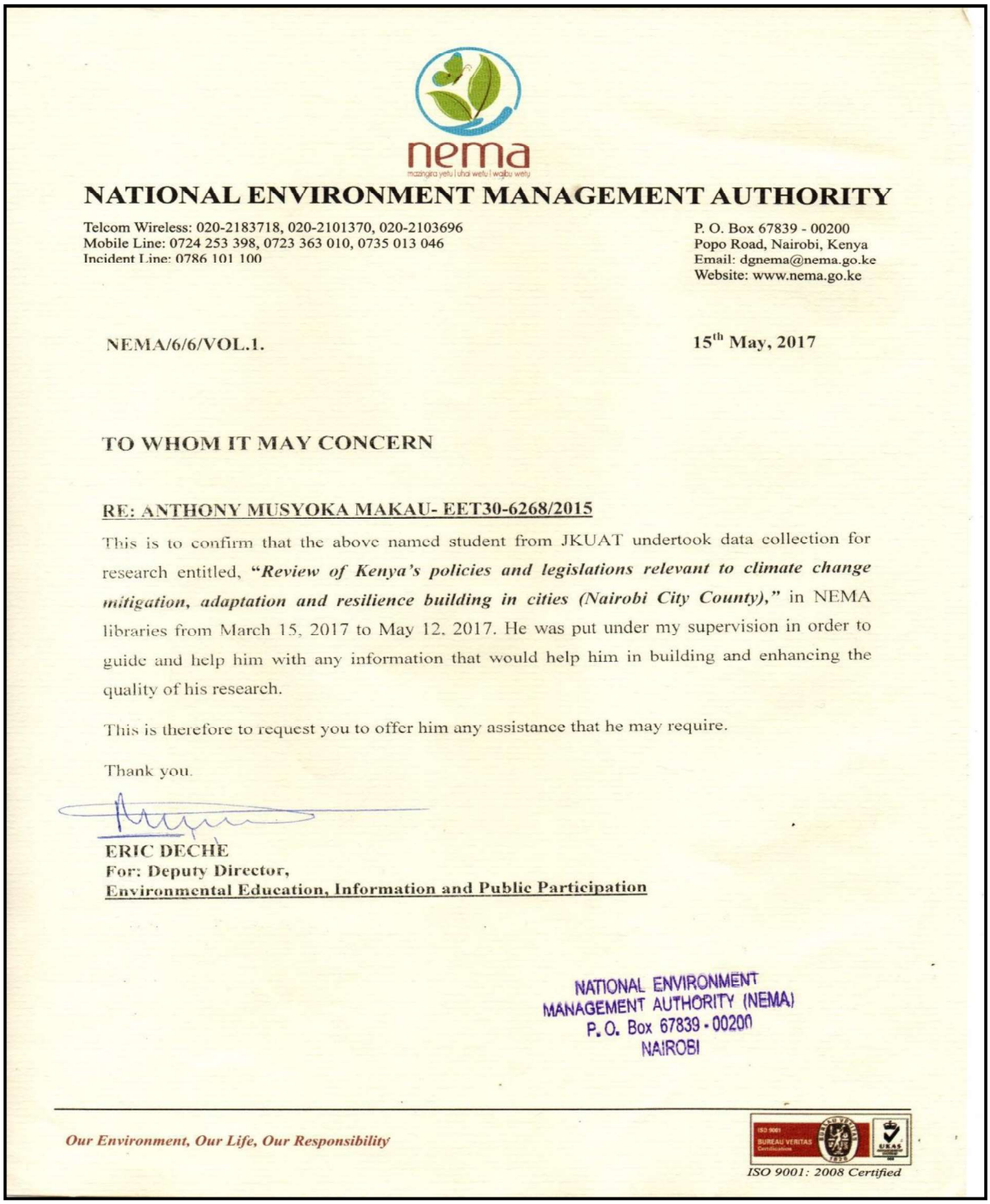
Prof. John Bosco Mukundi

University Supervisor, JKUAT

JKUAT is ISO 9001:2008 Certified – Setting Trends in Higher Education Research & Innovation

Appendix V

Recommendation Letter from NEMA



NATIONAL ENVIRONMENT MANAGEMENT AUTHORITY

Telcom Wireless: 020-2183718, 020-2101370, 020-2103696
Mobile Line: 0724 253 398, 0723 363 010, 0735 013 046
Incident Line: 0786 101 100

P. O. Box 67839 - 00200
Popo Road, Nairobi, Kenya
Email: dgnema@nema.go.ke
Website: www.nema.go.ke

NEMA/6/6/VOL.1.

15th May, 2017

TO WHOM IT MAY CONCERN

RE: ANTHONY MUSYOKA MAKAU- EET30-6268/2015

This is to confirm that the above named student from JKUAT undertook data collection for research entitled, ***"Review of Kenya's policies and legislations relevant to climate change mitigation, adaptation and resilience building in cities (Nairobi City County),"*** in NEMA libraries from March 15, 2017 to May 12, 2017. He was put under my supervision in order to guide and help him with any information that would help him in building and enhancing the quality of his research.

This is therefore to request you to offer him any assistance that he may require.

Thank you.

ERIC DECHE
For: Deputy Director,
Environmental Education, Information and Public Participation

NATIONAL ENVIRONMENT
MANAGEMENT AUTHORITY (NEMA)
P. O. Box 67839 - 00200
NAIROBI

Our Environment, Our Life, Our Responsibility

ISO 9001: 2008 Certified

Appendix VI

Research questionnaire

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY.

INSTITUTE OF ENERGY AND ENVIRONMENTAL TECHNOLOGY.

RESEARCH QUESTIONNAIRE.

Dear Sir/Madam,

This questionnaire is meant to seek your perception on matters of urban environment and climate information. It is purely academic and any responses obtained will be treated with confidentiality and anonymity. Kindly respond truthfully. Thank you in advance for your time.

Respondent information

Name: **……**

Gender: Male [ ] Female [ ]

Age: 15-24 [ ] 25-34 [ ] 35-44 [ ] 45-54 [ ] 55-64 [ ] 65-74 [ ] 75+ [ ]

Education: Primary or Less [ ] Secondary [ ] College/University [ ]

Profession: ……

How many years have you lived in Nairobi? **…….**

Location ……

Section 1: General information

1. Have you heard or read anything about climate change?

Yes [ ] No [ ] I don't know [ ]

2. What are your main sources of climate information? *Tick as many as you feel apply:*

Internet [ ]	Conference and workshop [ ]
Televisions [ ]	Newspapers [ ]
Radio [ ]	Government agencies [ ]
Specialist publication/ journals [ ]	Family/Friends [ ]
School/ College/ University [ ]	Environmental groups & NGOs [ ]

Others [ ] please specify them…….

3. Rate the following sources of information according to how they have influenced your understanding and appreciation of climate change.

Source	**A lot**	**A little**	**Not Very Much**	**Not at all**
A family member or Friend				
A scientist/ Academic Journal				
Government and Institutions				
An Environmental Agency (eg. NEMA).				
The media (ie. Television, Radio, Newspaper, Blogs)				
A public discussion or workshop or seminar I attended				
Others sources				

4. Thinking about the issues of climate in cities, how well do you feel you understand this?

Very well **[ ]** Fairly well **[ ]** Not very well **[ ]** Not at all **[ ]**

5. Various factors have contributed to climate change in Nairobi. Rate the following factors according to how you feel they have contributed to climate change in Nairobi.

Factor	**High**	**Moderate**	**Not Sure**
Rapid population growth.			
High rate of urbanization			
Destruction of forests and green areas around Nairobi.			
Emission from increased number of vehicles.			
Poor solid waste management.			
Industrial emissions from industries.			
Poor drainage systems to control flooding			
Poor land planning leading to congestion of buildings.			

6. As signs of climate change in Nairobi, rate the following aspects accordingly.

Factor	**Strongly agree**	**Agree moderately**	**Somewhat agree**	**Not agree**	**Strongly disagree**
Temperature fluctuations					
Extended dry seasons					
Extended cold seasons					
Change in rain patterns.					
Flooding during rainy season.					
Spread of infectious diseases eg cholera.					

Water scarcity					
Price fluctuations for agricultural commodities					
Human-human conflicts					
Human-animal conflict due to depletion of resources					
Migrations from areas of scarcity to areas abundance					

7. How much do you think the above-identified problem threaten your personal health and safety? (**Very serious (1)/ somewhat serious (2) not very serious (3) not serious at all (4) I don't know** (5).

Factor	**1**	**2**	**3**	**4**	**5**
Temperature fluctuations					
Extended dry periods					
Extended cold seasons					
Change in rain patterns					
Flooding during rainy season					
Spread of infectious diseases eg cholera.					
Price fluctuations for agricultural commodities					
Human-human conflicts					
Human-animal conflicts due to depletion of resources					
Migrations from areas of scarcity to areas abundance					

Section 2: Adaptation and intervention measures.

8. How much do you personally worry about climate change in Nairobi?

Great deal **[ ]** A fair deal **[ ]** Only a little **[ ]** Not at all **[ ]**

9. How concerned, if at all, are you about climate change in Nairobi?

Very concerned **[ ]** Fairly concerned **[ ]** Not very concerned **[ ]** Not at all concerned **[ ]** I don't know **[ ]**

10. To what extent do you agree with the following policy and legislation response strategies to the effects of climate change in Nairobi?

Intervention	Strongly agree	Agree	Disagree	Strongly disagree	I don't know
Encouraging use of public / transit mass transport to reduce the number of cars entering Nairobi.					
Encouraging use of non-motorized transport modes (cycling and walking) for short distances to reduce the need of using cars.					
Promoting low carbon technologies such as solar powered vehicles to reduce vehicular emissions.					
Embracing more effective traffic management technologies to reduce vehicle travel time and emission.					
Doing housing reforms in areas with informal settlements to meet required housing and sanitation standards.					
Embracing urban green planning in streets, parks, open spaces, gardens etc to manage Nairobi's temperatures.					
Adopting SMART building technologies such as green rooftops, green facades/walls to manage Nairobi's temperatures.					
Encouraging solar installation and water heaters on commercial and residential buildings to reduce use of electricity.					
Encouraging mixed land use planning such that offices, social amenities, shopping centres are located in residential areas to reduce commuter and transport impacts.					
Protecting sensitive areas such as Nairobi's river bank, forests, watersheds and other reserved areas from encroachment.					
Embracing use of weather and climate information in infrastructural development.					
Encouraging research to identify design and material that enhance resilience of infrastructure.					
Promoting construction of climate-proof infrastructures such as roads.					
Promoting proper waste management techniques to reduce drainage blockages and emissions from wastes.					
Promoting waste-energy capture technologies.					
Encouraging proper maintenance of drainage systems to manage flooding in rainy seasons.					
Encouraging water management technologies among city residents					

Intervention	Strongly agree	Agree	Disagree	Strongly disagree	I don't know
such as water harvesting, good use water in households etc					
Encouraging public participation in matters related to urban environment and climate change.					
Encouraging compliance with the existing policies and legislation that address specific issues related to climate change in Cities.					
Encouraging research and development to enhance climate change understanding and appreciation.					
Encouraging use of LPG (normal gas cookers) to reduce use of firewood and charcoal.					
Strengthening the capacity of national and county institutions responsible for climate change response.					

Appendix VII

Krejcie and Morgan

Table for Determining Sample Size of a Known Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Note: N is Population Size; S is Sample Size *Source: Krejcie & Morgan, 1970*